Community Assistantship Program

The Feasibility of Diversifying the Madelia Region with Multifunctional Landscapes: a Pilot Study of Alternative Futures

Prepared in partnership with
Rural Advantage

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EXECUTIVE SUMMARY

Background: Sustainable Biofuel Production in South-Central Minnesota

Renewable energy production from agricultural biomass is an important part of our energy future, but where will this biomass come from in the future? Farming methods based on crop monocultures and large inputs of energy, nutrients and pesticides are simple to implement but face increasing input costs and mounting demands to reduce water pollution. Fortunately, there is an alternative pathway: diversified perennial-based biomass farming. This approach has great potential to improve environmental quality and support economic revitalization in rural Minnesota, while still providing large amounts of affordable renewable energy.

This pathway to renewable energy capitalizes on the ability of diversified, perennial-based biomass farming to produce both biomass for energy and other valuable goods and services, such as control of agricultural pests, improved recreation, hunting and fishing, cleaner water, protection of biodiversity, and protection against expensive flooding. In essence, multiple benefits come from putting the right perennial plants in the right places in farm landscapes. In Minnesota, biomass can be produced from a range of perennial species, including mixtures of native prairie grasses, fast-growing trees and shrubs such as willows and poplars, and wetland species.

Diversified perennial-based biomass farming can create significant economic value for many different stakeholders, because income from biomass production will allow biomass farmers to produce other goods and services such as water-quality protection, wildlife habitat, or carbon storage at low cost. To capture this value, government agencies and private organizations concerned with agriculture, environmental quality, renewable energy and rural economic development should pool resources to support pilot-scale development of perennial biomass farming.

In south-central Minnesota, a solid foundation has been laid for a pilot project on sustainable bioenergy production in the area around the city of Madelia. The Madelia area, like much of rural America, is plagued with declining population, increasing poverty, high energy prices and low job growth. Diversified perennial-based biomass farming in the agricultural landscape around Madelia will create value for the community and region, including much improved hunting and fishing, ecotourism, flood protection, and improved water quality. This project (termed ‘The Madelia Model) will provide substantial benefits to the Madelia area, but more importantly will build a replicable model for sustainable bioenergy.

Background of the Pilot Study and Its Relationship to the Madelia Model

A group has been convened in Madelia by Linda Meschke of Rural Advantage of Fairmont, Minnesota, which included input from Steve Moses of Madelia Light and Power and Darin Haslip when he was with the Madelia Economic Development Authority (EDA), to explore the possibility of bioindustrial development within a 25-mile radius of Madelia. The group believes that there is a significant opportunity for future economic enterprises based on plant biomass, especially from woody and herbaceous perennial plant species, such as poplar, willow, and grasses.

The Madelia group asked Professors Laura Musacchio, Associate Professor in the Department of Landscape Architecture and Nicholas Jordan, Professor in Agronomy and Plant Genetics to carry out a pilot study as part of the large multi-faceted project known as the Madelia Model in 2006. The professors selected an interdisciplinary team of students to help with the project. The students are Anna Claussen (Landscape Architecture), Peter Hinck (Biosystems Engineering) and Peter Gillitzer (Natural Resources major). In addition, Linda Meschke plays an important role on the study team as a community partner.

Study Purpose

The purpose of this pilot study is to develop four alternative futures or scenarios for growing perennial biomass crops within a 10-mile radius of Madelia. The study's aim is to demonstrate how the multiple functions in Madelia's agricultural landscape can be strategically enhanced to include a broader range of economic and conservation choices for local farmers and residents.

Study Questions and Issues

This study has two scales of landscape analysis: a regional area, which includes the area within a 10-mile radius of Madelia (the Madelia region), and a subwatershed area, which includes Judicial Ditch 18 (JD-18). The region provides an opportunity to identify potential sites for perennials across different landscapes, watersheds, and communities while the subwatershed area allows a more detailed analysis at the farm level. For both areas, the research team's efforts addressed these questions and issues:

1. Which places and landscapes have high, moderate, and low suitability for woody and herbaceous perennials relevant to biomass for energy, bioindustrial feedstocks, and for continuous living cover that provide multiple benefits such as improved water quality, hunting and fishing opportunities, flood control, and local heritage?

2. What factors are most important to local leaders and experts for determining which places are best strategically for biomass energy, bioindustrial feedstocks, and continuous living cover?

3. Which future scenarios create landscapes with high, moderate, and low suitability for diversifying the rural landscape with multifunctional landscapes by 2026?

Geographic Information Systems (GIS) analysis was used to identify strategic places where change to another land use and land cover type creates opportunities for cultivation of woody and herbaceous perennials that yield abundant biomass for renewable energy production, which have beneficial effects on land stewardship and community quality of life. These strategic places were ranked according to criteria developed from the interviews with local leaders, farmers, and experts as well as important scientific literature and governmental sources. This information was used to develop four alternative future scenarios for diversifying the rural landscape with a diversity of perennial-based agriculture by 2026. This year was selected because it represents a planning frame of about one human generation.

Study Methods and Limitations

This project aims to provide practical assistance to the development process underlying the Madelia Model. For this purpose, we modified procedures of alternative futures analysis (Steinitz et al. 2003; Musacchio and Coulson, 2001; Nassauer and Corry, 2004). We structured the study as an exploratory tool to help the Madelia group better appreciate the factors and issues that will likely emerge in any effort to use perennial-based agriculture for sustainable bioindustrial development in the Madelia region. Each of the four alternative future scenarios and related sub-scenarios represent different hypotheses about what will emerge from the landscape as bioeconomic development proceeds, with associated changes in land use and land cover. The scenarios and sub-scenarios are grounded in the best information and assumptions that were available to the study team at the time. Our information sources included a literature review and interviews with experts from the government, university, and non-profit organizations and local residents who are from the Madelia region. The literature included recent newspaper articles about alternative energy issues from national, state, and local sources as well as a limited review of articles about alternative futures from academic journals. This information was then integrated into the four scenarios and sub-scenarios that were developed during several team workshops.

Because of this study's budget and time constraints, the alternative futures approach used was heavily modified to fit what was realistically possible during the summer 2006. The approach used was our team's first attempt to address the connection between public policy alternatives and bioindustrial development in the Madelia region. The emphasis of the approach was on using existing data sets that are readily available for the identification and prioritization of potential strategic planting sites in the Madelia region and JD-18.

This report can be best described as coarse filter that identifies potential sites with limited data. The team did not have access to the most up-to-date information about proposed wildlife corridors, open space acquisition, and other conservation and restoration initiatives. In addition, the potential sites identified in this report will need further study and field verification for potential land use, wetland, and habitat conflicts. The goal would be to minimize potential land-use conflicts and protect existing habitat. This limitation is discussed in more detail in the report.

Study Results

This executive summary will briefly review the descriptions of four scenarios that were developed during this study from team workshop, interviews, literature review, and so on. For complete details of study results, please read the scenarios section of the report.

Scenario 1 with Three Sub-scenarios: Precision Conservation

This scenario applies traditional best management practices (BMPs) in a more strategic and integrative fashion, by targeting areas that deserve maximum priority for conservation interventions, and also intensifies emphasis on conservation such as discouraging annual crop cultivation on steep slopes and environmentally sensitive areas. The goal is to push policies of relevant agencies such as Natural Resource Conservation Service (NRCS) and Farm Services Agency toward the strategic approach of conservation investments. For example, a corridor approach might be taken, aiming to address non-point source pollution more holistically by considering vulnerable areas across the landscape rather than working with land areas on an individual basis. This scenario builds upon past successes in buffer management and related BMPs for water quality and soil protection, including contour plowing, terraces, grass strips, and riparian corridors. This scenario is explicitly based on draft guidelines for precision conservation (i.e., nuanced implementation of soil and water conservation measures based on landscape attributes) developed by Linda Meschke and Richard Perrine. Important assumptions are that landowner buy-in increases and the land area devoted to conservation increases as well.

Building and expanding on traditional soil and water conservation practices, this scenario assumes that conservation activities can be more effective in protecting soil and water quality if they target the

most sensitive areas, especially areas with steep slopes and near surface water bodies. To create the maps for this scenario, the team produced a composite map of the landscape divided into the following precision conservation categories: 1) 0-2% slopes and 2-6% slopes greater than 200 feet from water related features; 2) 2-6% slopes within 200 feet of water related features; 3) 6-12% slopes; 4) 12-18% slopes; and 5) 18+% slopes. Sub-scenarios include these categories:1A: steep slopes only; 1B: adds gently sloped areas and areas near water; and 1C: similar to 1B but with squared field margins.

Scenario 2 with Three Sub-scenarios: Grassland Biomass

The grassland biomass scenario takes a step above and beyond the precision conservation scenario by proposing a Best Management Practice (BMP) approach that emphasizes a shift to perennial grassland vegetation, which may offer significant agroecological advantages in a region once covered by the tallgrass prairie. Corn and soybeans is still the dominant vegetation in the region, but more marginal farmland on wetter and steeper slopes shift to grassland. In this working landscape, substantial new areas of grassland are managed for bioenergy and to a lesser degree for biodiversity and visual quality. It is plausible for this scenario to occur at time when corn production is expanding for ethanol production while soybean production is decreasing in the region.

The team assumed that initial land-use shifts in the Madelia region will place grass on areas that are, at times, too wet for annual crops. To show what these areas might look like in the Madelia region, the team used county soil surveys to select all soils that are naturally “very poorly drained.” This designation does not consider the effects of artificial drainage, only the properties of the soil itself. The results of this analysis are: Scenario 2A includes very poorly drained soils; Scenario 2B is similar to 2A except that it also includes highly sloped areas; and Scenario 2C is similar to 2B, but it includes all moderately sloped areas and sites near water as well as squared field boundaries.

Scenario 3 with Three Sub-scenarios: Woody Biomass

Rather than expanding patches of grassland as the previous scenario, this scenario entails establishment of a mosaic of woody and grassland mosaic in selected areas of the region. Corn and soybeans will still be the dominant vegetation in the region, but more marginal farmland on wetter and steeper slopes will shift to a mosaic of woody plants and grasses. In this working landscape, new patches of woody plants will be managed for bioenergy and to a lesser degree for biodiversity and visual quality. It is plausible for this scenario to occur at time when corn production is expanding for ethanol production while soybean production is decreasing in the region.

The woody biomass scenario has much in common with the grassland scenario described above, but reflect requirements of tree crops noted above. Scenario 3A emphasizes establishment of wetland-tolerant species such as willow biomass plantations; it depicts the landscape that could result from planting willows on wetland soils that are currently used for annual crops. Scenario 3B depicts a landscape resulting from addition of an upland woody crop, such as poplar, which requires well-drained soil and tolerates moderate slopes, where it can provide some of the same soil and water conservation benefits as grasses. Scenario 3C modifies boundaries around willow and poplar to create rectangular fields for the surrounding annual crops.

Scenario 4 with Three Sub-scenarios: Pride of Place

This scenario has a different aim than the other scenarios because it becaue it aims to contribute to the reinvigoration of Great Plains life through the restoration of small towns, habitats and landscapes. This scenario directly takes on the issue of the human exodus in the Great Plains and parallel decline of rural quality of life by developing a regional strategy to stem rural depopulation. The strategy for this scenario is to recover and reinvigorate what is unique about the Madelia region like finding beauty in a working landscape of farms and small towns that is often considered to be low aesthetic quality. A process of habitat and farm enhancement is needed to bolster the agritourism and biodiversity potential of the Madelia region. The premise is that a beautiful and productive landscape will attract people to move to Madelia for its high quality of rural life and attract ecotourism and agritourism.

Scenario 4A adds wildlife habitat to an agricultural landscape via revegetation of road edges currently covered by perennial vegetation of poor habitat quality; the team also included buffers of 100 feet around intermittent ditches and streams and 200 feet around perennial streams in the region. For 4B, the team added corridors of habitat to interconnect existing habitat areas (grassland, woodland, wetland, or lake sites). Scenario 4C envisions a transformed landscape containing approximately 20% grasslands and 20% wetlands, as proposed by Minnesota Department of Natural Resources; to do so, the team drew blocks of wetland habitat on wetland soils and many areas of “very poorly drained” soils, and the team drew grassland habitat on steep slopes and in locations that connected with other habitat blocks. The team sought to make the resulting habitat blocks large, connected, and with rectangular field boundaries so that the remaining agricultural land could be used effectively and efficiently.

Concluding Observations

The Madelia Model, which is the project organized by Linda Meschke, is working to develop business plans that can be used to guide and raise capital support for ongoing efforts to pursue new economic opportunities based on sustainable bioeconomic development. Also, an engineering analysis and biomass inventory have tentatively identified a generation technology, gasification, as most appropriate for a renewable energy production facility at Madelia. The scenarios detailed in the report are intended to support a planning process for the Madelia Model that will engage multiple stakeholders in a learning group that will facilitate collective learning and collaborative action for sustainable bioeconomic development. Specifically, the scenarios will enable more detailed and systemic consideration of a multifunctional landscape surrounding Madelia. Previously, the nature of this landscape has been only generally described, with little specification of the scope, range and nature of realistic scenarios by which this landscape might be realized. The study outcome defines several of these scenarios in considerable detail, offering a key input for planning and development efforts.

Any statement of conclusions from these scenarios is entirely premature, as the scenarios are principally intended as a tool to support systemic thinking about sustainable bioeconomic development in the Madelia region, by individual stakeholders and by multistakeholder groups. However, the team offers several preliminary observations concerning implications of the scenarios:

1. Given plausible policy-changes scenarios, a large proportion of farmland in the Madelia region is better suited to cultivation of perennial crops. This finding is perhaps surprising, given this region is renowned for production of annual field crops. The maximum-implementations scenarios depicted in our report indicate that 25-50% of the landscape favors perennial crops. Under these scenarios, the implementation of effective multifunctional landscapes may be considerably facilitated. For example, the particular interests of many stakeholders may be more easily met, with fewer tradeoffs, in a landscape where a large fraction of land area is devoted to perennial crops and managed plant communities.

    - For Madelia Light and Power and other renewable-energy production interests, there is potential for a high density of biomass production in the landscape around Madelia. This potential reduces transportation and handling costs for biomass energy production; these costs are major constraints to biofuel production.

- For Minnesota Department of Natural Resources and other wildlife and biodiversity interests (e.g., Pheasants Forever, Ducks Unlimited, Izaak Walton League), the high density of perennial crops potentially providing high-quality habitat for species of conservation interest may mean that there is considerable leeway to harvest biomass and perform other management actions without major tradeoffs with wildlife conservation.

- For Watonwan County EDA, Minnesota Board of Soil and Water Resources, Minnesota Pollution Control Agency and other stakeholders concerned with water quality improvements in Watonwan River and surface waters, improvements to water quality from land-cover change may be relatively easy to attain, because relatively small financial payments may be sufficient to incent growers away from production of annual crops (assuming changes in current payments that incent production of these crops).

2. Given the extensive land area that is well-suited for perennial crops and plant communities, very different landscapes in terms of look/feel will result from these different scenarios 1-4. Therefore, there is a need for a multistakeholder process that will identify what goals and outcomes should be guiding landscape change projects associated with sustainable bioeconomic development. Failure to organize and support such a process may provoke significant future opposition and impose significant costs.

3. Given the extensive land area that is well-suited for perennial crops and plant communities, there is a need to anticipate landscape scale changes that may occur and lead to unintended consequences, such as significant changes in regional hydrology that may affect a wide range of stakeholders

INTRODUCTION

Relationship of this Pilot Study to the Madelia Model

Linda Meschke of Rural Advantage of Fairmont, Minnesota, created the Madelia Project, which included input from Steve Moses of Madelia Light and Power and Darin Haslip when he was with the Madelia Economic Development Authority (EDA), to explore the possibility of bioindustrial development within a 25-mile radius of Madelia. The group believes that there is a significant opportunity for future economic enterprises for the Madelia region based on plant biomass, especially from woody and herbaceous perennial plant species, such as poplar, willow, and grasses. These enterprises include emerging sources of plant-based producers, such as biorefinement of high-value chemicals and plant based substitutes in construction and other applications, and renewable biomass energy, such as bio-fuels. In addition to these economic opportunities, if these perennials were to be extensively grown in the corn and soybean landscape around Madelia, other values and benefits could be created for the community, including much improved hunting and fishing, ecotourism, flood protection, and improved water quality. These perennials may provide more stable agricultural production, economic return and rural vitality especially as this region of Minnesota experiences climate change.

The Madelia group asked Professors Laura Musacchio, Associate Professor in the Department of Landscape Architecture and Nicholas Jordan, Professor in Agronomy and Plant Genetics to carry out a pilot study as part of the large multi-faceted project known as the Madelia Model in 2006. The professors selected an interdisciplinary team of students to help with the project. The students are Anna Claussen (Landscape Architecture), Peter Hinck (Biosystems Engineering) and undergraduate Peter Gillitzer (Natural Resources major), In addition, Linda Meschke of Rural Advantage plays an important role on the study team as a community partner.

Study Purpose

The purpose of this pilot study is to develop four alternative futures or scenarios for growing perennial biomass crops within a 10-mile radius of Madelia. This study's aim is to demonstrate how the multiple functions in Madelia's agricultural landscape can be strategically enhanced to include a broader range of economic and conservation choices for local farmers and residents. The 10-mile radius was chosen becauses of time, budget, and data issues.

INTRODUCTION

Study Questions and Issues

The study has two scales of landscape analysis: a regional area, which includes the area within a 10-mile radius of Madelia (the Madelia region), and a subwatershed area, which includes Judicial Ditch 18 (JD-18). The regional area provides an opportunity to identify potential sites for perennials across different landscapes, watersheds, and communities while the subwatershed area allows a more detailed analysis at the farm level. For both areas, the research team's efforts addressed these questions and issues:

1. Which places and landscapes have high, moderate, and low suitability for woody and herbaceous perennials relevant to biomass for energy, bioindustrial feedstocks, and for continuous living cover that provide multiple benefits such as improved water quality, hunting and fishing opportunities, flood control, and local heritage?

2. What factors are most important to local leaders and experts for determining which places are best strategically for biomass energy, bioindustrial feedstocks, and continuous living cover?

3. Which future scenarios create landscapes with the high, moderate, and low suitability for diversifying the rural landscape with multifunctional landscapes by 2026?

The students and faculty worked to analyze the feasibility of diversifying the rural landscape with perennial crops that produce multiple benefits (e.g., wildlife habitat) in the Madelia region. Geographic Information Systems (GIS) analysis was used to identify strategic places where change to another land use and land cover type creates opportunities for expanding a select group of woody and herbaceous perennials relevant to biomass energy,quality of life issues, and land stewardship concerns. These strategic places were ranked according to criteria developed from the interviews with local leaders, farmers, and experts as well as important scientific literature and governmental sources. This information was used to develop four alternative future scenarios for diversifying the rural landscape with a diversity of perennial-based agriculture by 2026. This year was selected because it represents a planning frame of about one human generation.

Precedents for this Study

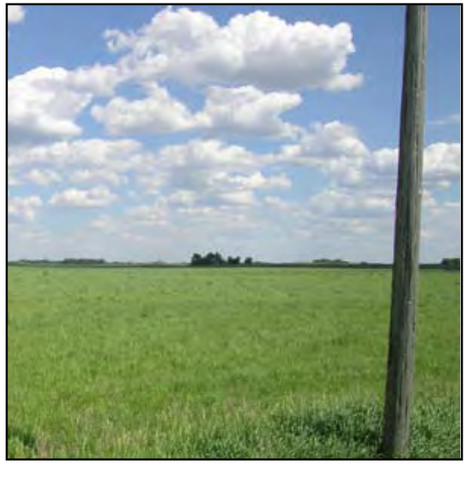
Like any type of research, this study is related to other studies, particularly the major international trend of integrative approaches of ecological and social sciences that are applied to environmental and societal problems. A number of landscape scholars across the disciplines emphasize the need for such approaches (Moss, 2000; Fry 2001; Tress and Tress, 2001; Tress et al. 2001; Tress and Tress, 2005; Musacchio and Wu, 2004). In particular, there is an emphasis on the need to make the rural landscape more multifunctional; meaning, agricultural land is valuable for farming and ranching (Fry 2001) as well as for conservation and protection of water quality, habitat, historic features, and biodiversity, which in some cases can produce additional sources of income for farmers.

The challenge for researchers is that there are few examples of rural regions in the United States that are managed as multifunctional landscapes. At the farm scale, there are more examples, but these demonstration projects are considered to be experimental in most cases. Researchers are trying to fill this gap by using the alternative futures approach to propose different scenarios about how public policy would provide incentives for farmers to manage their land as multifunctional landscapes. Some of these studies are exploratory, like this pilot study, and are used to establish new interdisciplinary teams. Other projects are large teams of researchers from several universities who have been awarded major grants, such as the alternative futures project recently completed for Iowa's agricultural landscape (Nassauer and Corry 2004; Santelmann et al. 2004).

Moreover, this study relates to other studies about the potential biomass energy values of prairie perennials. At the University of Minnesota, David Tilman's biofuel research at Cedar Creek, a long-term ecological research project, is an excellent example.

Study Limitations

Because of the study's budget and time constraints, the alternative futures approach used was heavily modified to fit what was realistically possible during the summer 2006. The approach used was our team's first attempt to address the connection between public policy alternatives and bioindustrial development in the Madelia region.The emphasis of the approach was on using existing data sets that



are readily available for the identification and prioritization of potential strategic planting sites in the Madelia region and JD-18. Our approach was different than other alternative futures projects (e.g., Nassauer and Corry 2004; Santelmann et al. 2004) which had large grants and were able to create detailed alternative policy scenarios and landscape plans with sophisticated GIS modelling techniques.

This report can be best described a coarse filter that identifies potential sites with limited data. The team did not have access to the most up-to-date information about proposed wildlife corridors, open space acquisition, and other conservation and restoration initiatives. In addition, the potential sites identified in this report will need further study and field verification for potential land use, wetland, and habitat conflicts. Any remnant habitats, wetland designations, and habitat conservation schemes take precedent over this study, and the goal will be to minimize any conflicts between land conservation, water protection, and perennial biomass energy goals. Additional research will be needed to determine how compatible the perennial biomass plantings are with existing habitat conservation sites and other types of habitats as well as with farmers' land management values and practices.

This study had some other important limitations. The study was first and foremost an educational experience for the students and collaborative learning took a significant amount of time during the study. Another limiting factor was that this study was not designed to address the ethanol and corn debate, which has become increasingly present in the national and state media in 2006 and 2007. Most of the strategic places for perennials identified in this report are considered to be marginal or very marginal for corn and soybean production.

Report Organization

This report is organized into a summary of research findings useful for strategic and community planning efforts in Madelia and surrounding counties. The first section is a brief overview of background information about the Madelia region's biophysical, historical, and cultural characteristics. The second section reviews the methods and process that was used in the study. The third section reviews the major findings of the local and expert interviews about landscape change and bioindustrial development in Minnesota. The fourth section presents four alternative future scenarios at two scales: a regional area, which includes all counties within a 10-mile radius of Madelia, and a subwatershed area, which includes JD-18. A set of illustrative maps identify and rank strategic places for a select group of woody and herbaceous perennials relevant to biomass energy and bioindustrial feedstocks and opportunities, to add continuous living cover, and to improve quality of life issues and land stewardship concerns. The fifth section provides major conclusions from the study. The appendix has a table with environmental factors and scenarios matrix, potential perrenial plant communities, and a qualititative review of existing federal and state policies that might be a starting point for the strategic planting of perennial-based agriculture.

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The Relation of This Study to Other Community Efforts

The Madelia Model, which is the project organized by Linda Meschke, is working to develop business plans that can be used to guide and raise capital support for ongoing efforts to pursue new economic opportunities based on sustainable bioeconomic development. Also, an engineering analysis and biomass inventory have identified a generation technology, gasification, as most appropriate for a renewable energy production facility at Madelia. As mentioned above, these new opportunities arise both from the biomass commodities produced by these crops and from other benefits, such as the large economic benefits that can come from enhanced hunting and fishing and ecotourism. In addition, the community will be starting a strategic planning process to assist in defining how the community might move forward. Outputs from this study will compliment this community effort in these ways:

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1. A positive first step in the strategic and community planning process will be accomplished with this research study. In particular, the idea of a diversified, perennialized landscape producing biomass for energy and bioindustrial uses has been only generally defined, without definition of the scope, range and nature of particular 'modes' by which this landscape-change vision might be realized. This study outcome defines several of these modes in considerably greater detail, which can be used as key input in ongoing planning and development efforts in support of the Madelia Project.

2. Local leaders will be able to make more informed decisions about the future direction of economic development in Madelia that is grounded in concern for maintaining a high quality rural lifestyle and place. This is especially true if the next step in the process is to hire outside consultants who will develop more specific plans for development and growth of bioenergy and other biomass-based industries.

3. Finally, local leaders will have results and recommendations that will be used to leverage assistance to move all of this forward by 2026. People living in and around Madelia, as well as a variety of technical experts, have provided input into the process via interviews, in defining what sort of landscape changes would be preferred.

BACKGROUND INFORMATION
Geography & Location
Southern Minnesota

Geography
This part of southern Minnesota was shaped by the last glacial period, about 10,000 years ago. The glaciers left behind the clay-rich soils that give the region its agricultural productivity and created a gently rolling landscape that is ideal for farming. Minnesotans have worked in the last 100 years to further improve agriculture in the region by installing networks of drainage pipes and ditches. These drainage networks help to increase the rate that water flows through the dense clay soils and keep most of the prairie potholes (depressions left by the glaciers) from filling with water and returning to their natural wetland state.

Historic Settlement in Southern Minnesota
Drawn here by herds of large game, the first settlers in Minnesota traveled here on foot during the last Ice Age. The ancestors of these nomads, known today as Native Americans, became the next settlers of the land. The red pipestone of southern Minnesota was highly valued by the Indians and used to make ceremonial pipes. Jeffer's Petroglyphs, in Southwestern Minnesota, still bears rock carvings of people, animals and weapons inscribed five thousand years ago. They also left behind over 10,000 sacred earth mounds that were used for graves and ceremonies (Shubach, 2007).
The first European presence in Minnesota came with the French fur trading of the late 1600's. By the 1800's many of the Native Americans were pushed either to the north or out of the region that would soon be declared the state of Minnesota. The Dakota Indians signed a treaty with the United States government giving up their land where the Minnesota River meets the Mississippi River, and thus becoming the first region that could be legally settled (Schubach, 2007). Treaties signed in 1837, ceding land near the St. Croix and Mississippi Rivers, brought the cutting and harvesting of lumber. Much of southern Minnesota, except some land along the Minnesota River, was ceded in 1852 by the Dakota tribes. Soon after the treaties of the 1850's thousands of people poured in to build farms, cut timber, and divide the land up into townships. In just over a decade the population surged from an estimated 3,814 people to an incredible 172,072 inhabitants (American Civil War, 2007). By 1858 Minnesota was declared the 32nd US state.
The early 1860's brought war for both Minnesota and the nation. The American Civil War, which took over 600 Minnesotans' lives, sparked a separate war on Minnesota territory between the Native Americans and the European settlers. Due to preoccupation with the American Civil War the payments to the Native Americans guaranteed in the treaties were not paid, thus causing the Native Americans to grow very discontented. On Agust 17th, 1862, five American settlers were killed by a group of dissatisfied Dakota Indians. Over the next 6 weeks 500 settlers and an unknown number of Dakota would die in an undeclared war known as the Sioux Uprising. Later on 38 Dakota Indians were hung, in the largest mass execution in U.S. history (American Civil War, 2007).






Important Events in Land-Use History

	1900-1910	1910-1920	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000
CONSERVATION	1900. Gen. Christopher C. Andrews called for the creation of an international park along the Minnesota-Ontario border. 1902. President Theodore Roosevelt signed a law to authorize the country's first national forest- what is now the Chippewa National Forest. 1903. Mary Gibbs defended Minesota's first state park, Itasca, by defying loggers' threats and releasing water from an artificial flooding to prevent destruction of a pine forest.			1931. Public support led to the creation of the state's Department of Conservation to "bring under one head and correlate all conservation activities and to take conservation out of politics."		Minnesota Bureau of Game Supervisor Richard Dorer championed a Save the Wetlands Program that conserved more than 1 million acres of habitat.	1963. The Minnesota Resources Commission began distributing funds from a new state tax on cigarettes, funding 11 new state parks and expanding 17 others.	The Pig's Eye sewage treatment plant in the Twin Cities dumped over 4 billion gallons of raw sewage into the Mississippi River annually. Citizens banded together and won a court fight to clean up the river, restore its fisheries, and rid it of foul algae blooms. 1974. Responding to suburban growth, civic leaders and citizens launched the Metropolitan Regional Parks System, which today serves over 30 million park guests per year.	1986. An enourmous coalition of conservationists united to support and pass the state's Reinvest in Minnesota legislation, which provided incentives to farmers to help improve critical fish and wildlife habitat. 1988. Minnesotans voted to establish an Environmental Trust Fund and to dedicate a portion of state-run lottery proceeds to the first established trust of its kind in the nation.	1991. The Minnesota Wetland Conservation Act became law, establishing a goal of no net loss in the quality and quantity of wetlands in the state.
AGRICULTURE	Continued Agricultural settlement on the Plains and Farm Prosperity. Urban issues on rural life instensify. 1902. Farmers Union Started. Reclamation Act. 1905. International Institute of Agriculture established. Forest Service Created. 1907. Panic of 1907.	1914-1918 World War I Farm Credit is a steadily growing rural issue. 1912. Plant Quarantine Act. 1913. Federal Reserve Act passed. 1914. Smith-Lever Extension Act passed. 1914. Cotton Futures Act. 1916. Federal Farm Loan Act. 1917. Food Control and Production Acts. 1919. American Farm Bureau Federation	Agricultural Surpluses become chief agricultural issue. Beginning of long term agricultural depression. 1920. Collapse of Agricultural prices. 1925. Beginning of Master Farmer movement. 1926. First hybrid-seed corn company organized. 1928. Future Farmers of America founded.	The Great Depression. Farm to Market Roads emphasized in Federal road building. 1932. Drought and dust-bowl conditions develop. Farm prices and income reach Depression bottom. 1933. Agricultural Adjustment Act initiates crop and marketing controls. 1934. Executive orders withdraw public lands from settlement, location, sale, or entry; Taylor Grazing Act. 1936. Rural Electrification Act improves rural quality of life. 1937. Agricultural Marketing Agreement Act 1939. Technical Agricultural collaberation with South American countries.	World War II: Wartime recovery and postwar boom. Frozen foods popularized. Increased use of herbicides and pesticides. 1945. Food and Agriculture organization of the United Nations established. 1947. General agreement on Tariffs and Trades established between member nations. 1948. Foreign Assistance Act provides for European Recovery Program.	Television widely accepted; many rural areas lose population as farm family members seek outside work. 1950. Large Surpluses 1954. Agricultural Trade and Assistance Act 1955. National Farmers Organization formed 1956. Soil Bank Program authorized 1957. Poultry Inspection Act 1958. Humane Slaughter	Government uses food surpluses for the needy at home and abroad; State legislation to keep land in farming gains impetus. Soybean acreage expands as an alternative to other crops. 1964. Trade Expansion Act 1966. Presidents Committee on rural poverty appointed	Inflation rates increase, while economic growth slows. Certified Organic farms organized. 1970. Plant Variety Protection Act. First Earth Day 1972. Rural Development Act. Russian wheat sale bring higher farm prices. Clean Water Act. Increased exports to Soviet Union absorb agricultural surpluses. 1979. Grain Embargo of Soviet Union following its invation of Afghanistan	Farm financial crisis affects farmers with heavy debt loads. European grain and animal exports become more competitive. Rural counties experience decline. More farmers use no-till or ridege-till methods. 1980-81. Recession. 1987. Farmland values bottom out after a 6 year decline. 1988. One of the worst droughts in the Nation's history hits Midwest farmers. 1989. Sale of farm equipment rebounds; more farmers use low-input sustainable agriculture techniques.	Rural coutnies gain population after losing ground in the 80's. Information technology and precision agriculture increasingly used. Genetically engineered crops and livestock appear. 1990. Organic Food Production Act 1998. Price slump caused by large commodity surpluses. 1989. Emergency farm assistance acts provide relief for disasters and market losses. 2000. USDA unvelis organic standards and official organic seal.
	Farmers in Labor Force: 38% Number of Farms: 5,740,000 Average Acres: 147	Farmers in Labor Force: 31% Number of Farms: 6,366,000 Average Acres: 138	Farmers in Labor Force: 27% Number of Farms: 6,454,000 Average Acres: 148	Farmers in Labor Force: 21% Number of Farms: 6,295,000 Average Acres: 157	Farmers in Labor Force: 18 % Number of Farms: 6,102,000 Average Acres: 175	Farmers in Labor Force: 12.2 % Number of Farms: 5,388,000 Average Acres: 216	Farmers in Labor Force: 8.3 % Number of Farms: 3,711,000 Average Acres: 216	Farmers in Labor Force: 4.6 % Number of Farms: 2,780,000 Average Acres: 390	Farmers in Labor Force: 3.4 % Number of Farms: 2,439,510 Average Acres: 426	Farmers in Labor Force: 2.6 % Number of Farms: 2,143,150 Average Acres: 461

Adapted From: USDA website (http://www.agclassroom.org/gan/timeline/index.htm) and The Campaign for Conservation

BACKGROUND INFORMATION
Geography & History
Madelia Region

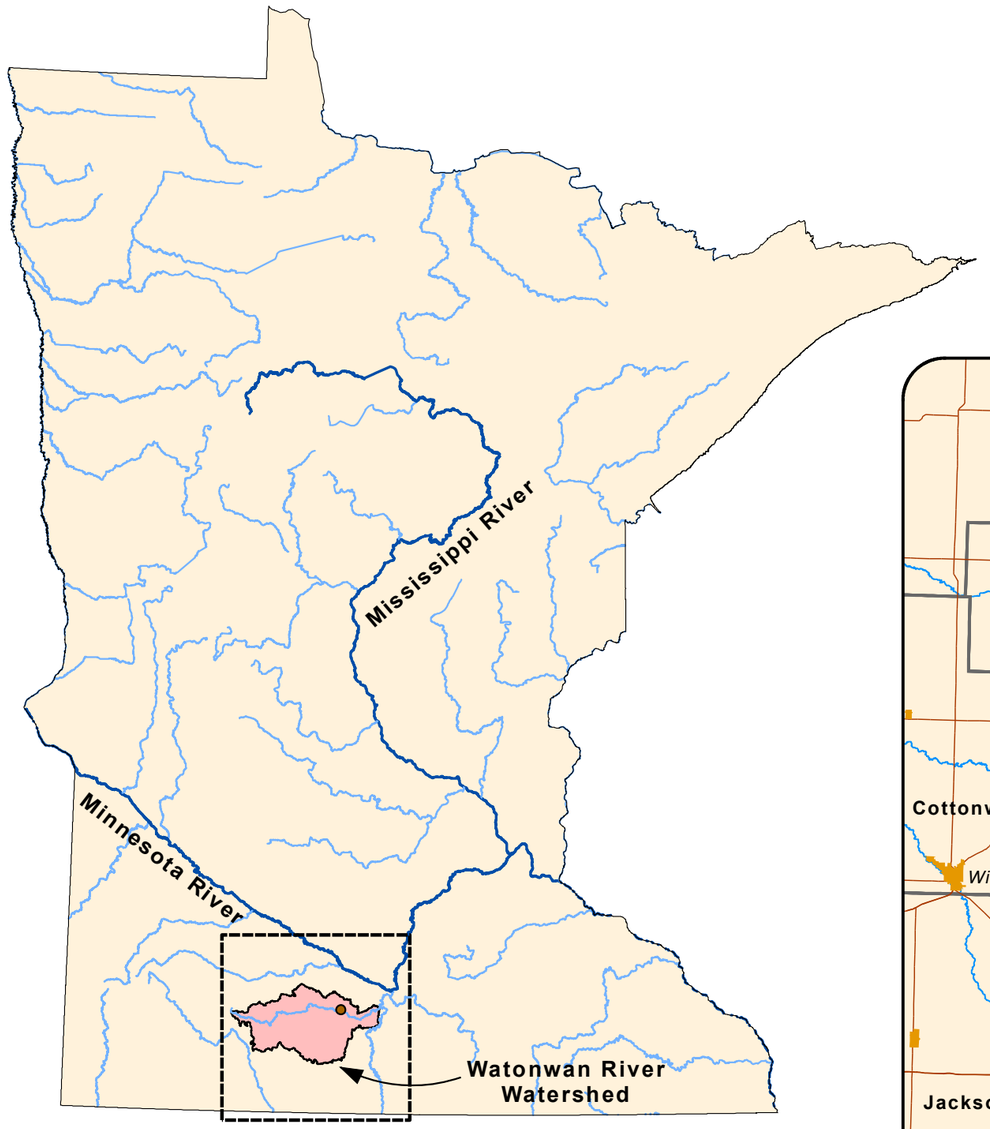
Madelia Area Geography and History
Madelia, population near 2300, is not a county seat but is located in the middle of four significant regional government centers. Mankato and New Ulm both lie along the Minnesota River and are major hubs for commerce, tourism, and education. Fairmont, 25 miles south of Madelia and located along interstate 90, is likewise a major economic and residential center for the region. Saint James, the county seat for Madelia's Watonwan County, is located 10 miles southwest of Madelia and is home to several important industrial plants that employ a number of the county's residents.

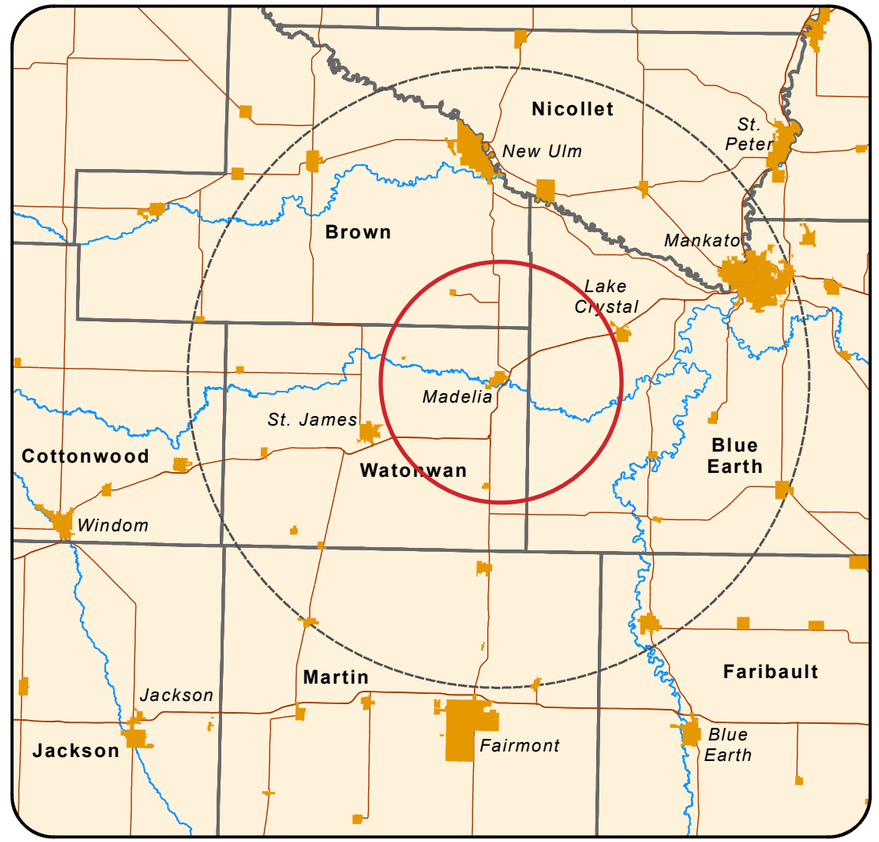
Madelia sits on the banks of the Watonwan River, in one of the major watersheds that make up the greater Minnesota River Basin. This south-central part of the state contains some of the richest agricultural soils in the world, and consequently it is the most intensively-managed agricultural region in Minnesota—recent land use studies show that 85% of the region is used for row-crop agriculture. Like much of the rest of the larger Corn Belt, the crops produced around Madelia are primarily corn and soybeans as well as hogs and poultry.

Madelia History
Madelia was incorporated as a village in 1873. Prior to this it was considered a hamlet that was composed of a cluster of buildings. Early in the year of 1853, the Traverse des Sioux treaty was ratified, thereby opening the richest section of Minnesota soil to white settlement. Prior to this treaty, all the land was Indian land and was commonly known as "Suland" (Madelia in Retrospect). The town of Madelia predates Watonwan County, as Madelia was originally part of Brown County.

Watonwan County History
The first settlers entered Watonwan County as early as 1855. Six years later, in 1861, the county was organized and J.T. Furber, C.M. Pomeroy, and Ole Jorgenson were appointed commissioners. The county was described as well watered by numerous lakes, rivers, and creeks; the surface gently rolling, the soil rich and adapted to general farming and the transportation facilities equal to the demands of a thrifty agricultural population. The soil of Watonwan County was known to produce in abundance all of the cereal crops known to this latitude while also provide nutritious pasture for livestock and for the making of dairy products.

Madelia Context Maps





Legend

- Municipalities
- Major Rivers
- Major Roads
- County Boundaries
- 25-Mile Radius Around Madelia
- 10-Mile Study Area Radius

0 2.5 5 10 15 20 Miles

METHODS

Process

The origins of this study as an exploratory and practical tool influenced its methods and procedures. For example, important influencing factors included: 1) the complexity of potential ecological and social interactions in the landscape; 2) the feasibility of perennial-based agriculture as the basis for a new regional economy in the Corn Belt; 3) the lack of information about the dynamics of landscape transformations for bioindustrial development and land protection in the Corn Belt; and 4) the large area of the study given temporal and budget constraints.

Given these four factors, the team used modified procedures for what is known as alternative futures analysis in the discipline of landscape planning (Musacchio and Coulson, 2001; Steinitz et al. 2003; Nassauer and Corry 2004). The study was structured as an exploratory tool to learn more about the complexity of factors and issues about landscape patterns that will likely emerge from different but plausible futures for the use of perennial-based agriculture in bioindustrial development and land protection. The emphasis of the approach was on using existing data sets that are readily available for the identification and prioritization of potential strategic planting sites in the Madelia region and JD-18.

Each of the four alternative future scenarios and related sub-scenarios represent different "hypotheses" about what will emerge from the landscape so to speak when the local economy of Madelia switches from a crop-based economy for human and animal food consumption to one focused for energy and food consumption. The scenarios and sub-scenarios are grounded in the best information and assumptions that were available to the study team at the time. The information sources included a literature review and interviews with experts from the government, university, and non-profit organizations and local residents who are from the Madelia region. The literature included recent newspaper articles about alternative energy issues from national, state, and local sources as well as a limited review of articles about alternative futures from academic journals. This information was then integrated into the four scenarios and sub-scenarios that were developed during several team workshops, which also included the participation of Linda Meschke of Rural Advantage. A full description of mapping process for these scenarios and sub-scenarios is included in this report.

Additional Information: Interviews

Two separate but parallel interview processes were conducted in summer of 2006. The first interview process included 13 local residents, farmers, and experts, who were asked questions about past, present, and future landscapes in the Madelia region and southern Minnesota. The procedures and results for are discussed in the interview section of this report. The second interview process had a different purpose and focused 7 interviews with agricultural and conservation experts. They were asked questions about how existing policies and biomass perrennial crops. See the appendix for a complete review of the results for these interviews.

Past, Present, and Future Landscape Interviews

The first part of interview questions focused on gathering landscape memories and preferences about the past and present landscape of the Madelia region and southern Minnesota and their thoughts about the effectiveness of current agricultural policies and environmental set aside programs. The second part of interview questions asked them to visualize what their ideal future landscapes for these places would look like and how shifts in agricultural policies and environmental set aside programs, which would promote perennial based agriculture for bioindustrial development and land protection, would affect the appearance of this ideal landscape.

During a series of workshops, the research team used the interview findings to develop composite descriptions of the past, present, and future landscapes. The descriptions were enhanced through additional research and insights from the team's shared knowledge and experiences about the project. The team used a technique known as the mind map to find patterns of related ideas among all of the available information sources. The results are described in the interview section, which includes written and graphic representations of the mind maps for the Madelia region's past, present, and future landscapes.

Additional Information: GIS Analysis for the Four Scenarios and Sub-Scenarios

In order to understand the intricacies of the landscape around Madelia and to help create meaningful scenarios for landscape change, the team developed a spatial database of maps and otherspatial information for the area. GIS and photograph data were obtained from publicly available sources such as the Minnesota DNR's online Data Deli, the national NRCS soils information website, and the historical photo library at the University of Minnesota. Information at two different scales was occasionally sought so that the team could use more-detailed data to create maps for the JD-18 watershed and more coarse data for the 10-mile radius maps. In addition, the team visited the

JD-18 watershed and took detailed notes about current patterns of land use, residence, and apparent landscape changes.

The primary spatial data types were: 1) 30-meter digital elevation model of southern Minnesota, which showed elevations for each 30m x 30m grid cell; 2) SSURGO county soil surveys, which outlined the various soil types found on the landscape and provided a general description of each soil's physical, chemical, and agronomic properties; 3) land use data from Minnesota's 1990 Census of the Land that divided all land uses into eight categories such as urban, agricultural, grassland, open water, and so on; 4) color aerial photos taken by the Farm Services Agency in 2003-2004; and 5) maps of stream networks, public drainage, lakes and wetlands from a variety of sources.

The team used all of this information within the framework of a computer-based GIS to visualize features of the landscape and perform various analyses. The techniques that the team used included grouping features by soil type, suitability for growing various crops, and surface slope; as well as creating buffers of various widths around important features. Analysis techniques specific to each scenario are described more fully in the rest of the report. The results of the analysis form the basis for the scenario maps described previously.

In most cases the sub-scenarios that involve extensive hand drawing at the scale of JD-18 —those with an emphasis on preserving existing homes and roads while creating rectangular field boundaries—do not include a map at the 10-mile radius scale because of the detailed work required was beyond the budget and time constraints of this study.

Limitations of Study Methods

Creating these maps and scenarios often requires a significant amount of data and information about conditions at the site in question. The most detailed scenarios are often limited to the smaller confines of the JD-18 watershed because the team found that only at the small watershed scale could the interactions between existing land uses, slopes, soils, and hydrology be fully understood. The maps that may most closely match the ways that farmers could implement these changes on the landscape—the squared field maps—required significant hand drawing to determine and delineate the field boundaries. In addition, because of the volume of data required in the soils and slope maps, it was not possible for the team to work on areas any larger than a 10-mile radius around Madelia.

Maps of smaller areas, such as the JD-18 watershed, are very useful because farmers, landowners, residents, policymakers, and researchers alike can begin to grasp the set of possible landscapes for that given area. However, intense study of a single watershed does not necessarily reveal the larger pattern of landscape uses and connectivity. The JD-18 watershed, for example, does not contain any perennial streams or much surface water, so the analysis does not rely heavily on creating buffers around these sensitive landscape features. Maps of a larger area—such as the 10-mile radius—can show broad landscape trends and illustrate how various patches and corridors of the landscape work together. They can be useful for broad planning efforts or for identifying regional habitat corridors. However, these broad-scale maps do not provide much information on the specifics of the sites in question, including the complex issues that might arise as landowners make decisions about how to use their land, how state agencies should coordinate proposed conservation schemes, or how perennials for biomass energy can be managed for habitat.

This study will aid local decision making efforts in Madelia, but it is important to know that the results of this study have limitations. This study is not a comprehensive look at the challenges and opportunities of integrating perennials for bioenergy and land conservation into Madelia's rural landscape. It was funded as a pilot study to make a first attempt at addressing the many questions surrounding the feasibility of perennial-based agriculture in a corn-soybean landscape typical of southern Minnesota. There were many things that the team did not have time to thoroughly address. In addition, one of the major goals of this study was to provide an interdisciplinary research experience for the faculty and students, and developing the team's vision for the project took time, so the team could build enough shared experiences.

The type of detailed and time-consuming watershed-scale analysis that has been outlined here will be the most useful to residents, landowners, and planners as they address the realities of the site and important factors such as land ownership and the presence of roads, utilities, drainage tile, and so on. Thus while maps and analysis of the larger region are helpful, they may be difficult to complete to the necessary detail for regional decision making. For example, the team had very limited information about proposed habitat corridors, wetlands, remnant habitats, and conservation reserve lands, so the scenarios and sub-scenarios do not reflect the input of this information.

What If?

In the scenario section the team will present four alternative future scenarios for Madelia region and JD-18 sub-watershed. The scenarios and maps are meant to generate discussion about the question: What if? It is the team's intent to provide a range of choices for local residents and experts. Ultimately any changes to the landscape around Madelia will be made one at a time, by individual landowners, working first in the context of their local surroundings and then their place in the Madelia region.

INTERVIEWS

Past Landscape

Mind Map of Landscape Change in the Madelia Region: A Summary of Research Findings

A total of 13 interviews were completed with local residents, community leaders, conservation and agricultural experts, and farmers who are familiar with the landscapes of Madelia region and southern Minnesota. The first part of the interview questions focused on gathering landscape memories and preferences about the past and present landscape of the Madelia region and southern Minnesota and their thoughts about the effectiveness of current agricultural policies and environmental set aside programs. The second part of the interview questions asked the subjects to visualize what their ideal future landscapes for these places would look like and how shifts in agricultural policies and environmental set aside programs, which would promote perennial based agriculture for bioindustrial development and land protection, would affect the appearance of this ideal landscape.

During a series of workshops, the team used the interview findings to develop composite descriptions of the past, present, and future landscapes. The descriptions were enhanced through additional research and insights from the team's shared knowledge and experiences about the project. The team used a technique known as the mind map to find patterns of related ideas among all of the available information sources. The results are described in this section, which includes written and graphic representations of the mind maps for the Madelia region's past, present, and future landscapes.

The Past Landscape

The region surrounding Madelia has undergone numerous changes since the time of European settlement in the mid-1800's. For nearly all of that time, however, agriculture has dominated the landscape. The changing practice of agriculture has been the most significant influence in the region, and the effects of agriculture on the people and the landscape have driven the evolution of Madelia and its surroundings.

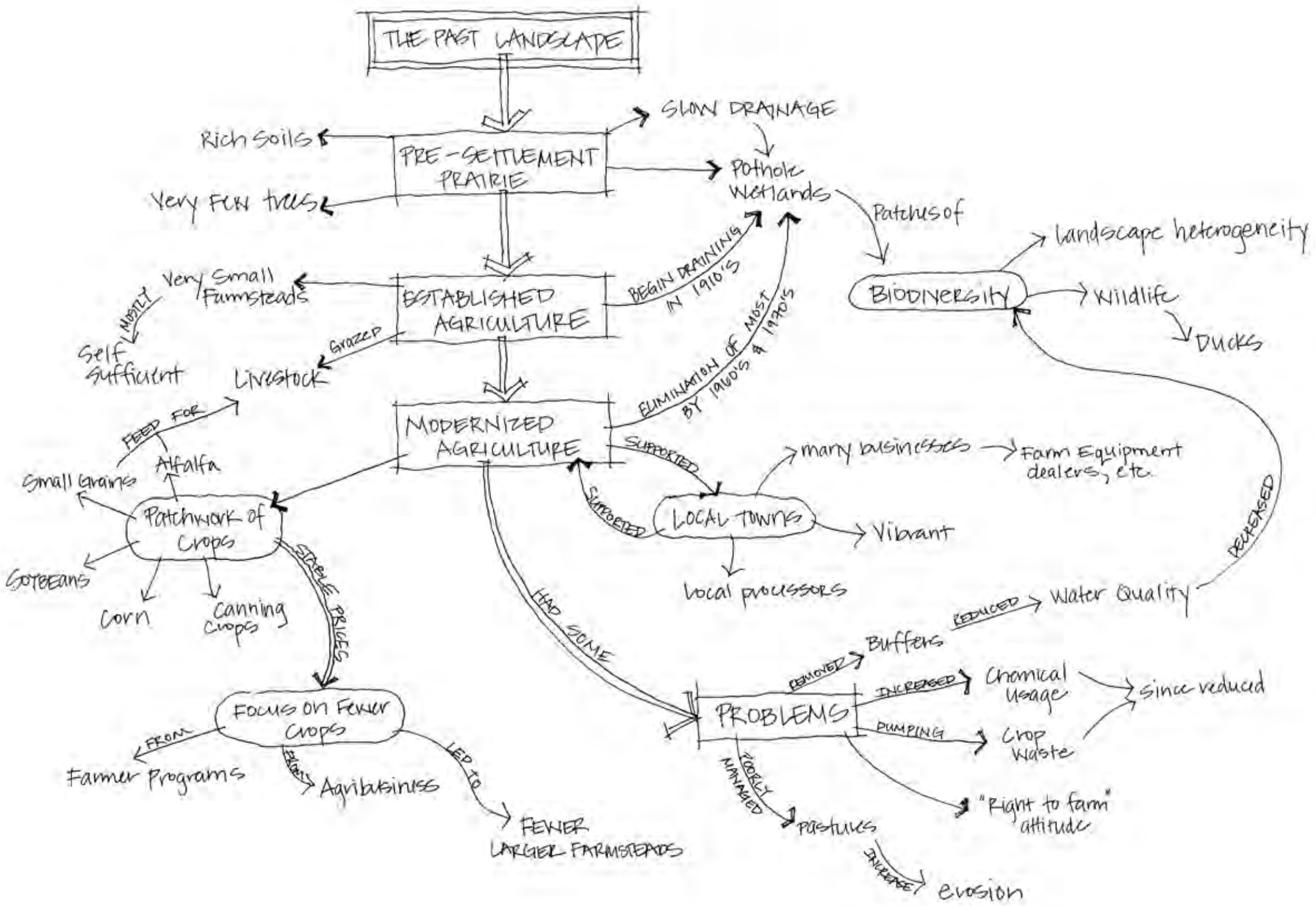
At the time of European settlement the Madelia region consisted of extensive prairies pocked with pothole wetlands. There were very few trees on this visually open landscape, except on the edges of some of the larger lakes and streams where they were protected from the frequent fires. The prairie and pothole ecosystem was home to a great deal of biodiversity in the form of prairie and wetland plants as well as birds and other wildlife. Although the landscape was consistent across much of the region, it varied at a local scale because of the pothole wetlands and other breaks in the landscape.

European settlers recognized the richness of the region's soils and began introducing till agriculture throughout the region in the late 1800's. In the 1910's farmers began to dig ditches and install drainage tile in order to increase the acreage that could be farmed profitably. Although drainage removed some of the biodiversity from the landscape by reducing the number of pothole wetlands, farms themselves produced a greater diversity of crops than today including corn, small grains, and hay for livestock. Most of the livestock in the area was pastured a good portion of the year, and farms were for the most part small and self-sufficient—although there were a few large farms that established in the Madelia region to sell cash crops that were exported on railroads.

During the 20th century agriculture continued to modernize and change, as did the landscape around Madelia. In the middle of the century farm fields in the area contained a patchwork of crops, including crops grown for livestock feed and canning crops that were used by local food processors. Farmers worked very hard, but the diversity of crops and relatively stable prices meant that most farmers were able to achieve a decent living on small-to-medium farms. Agriculture largely supported small towns—which in turn supported agriculture through their farm equipment dealers, grain elevators, processors, and other farm-oriented businesses. These small towns were vibrant and full of a sense of community.

Modern agriculture also created some problems, as perceived by those who experienced them. Some farmers viewed marginal lands as worthless and did not adequately care for these areas, such as farmers who allowed their livestock to overgraze steep hillsides—leading to problems with erosion—and those who dumped crop waste into ravines. By the 1970's most of the prairie pothole wetlands were drained, removing some biodiversity from the landscape. Chemical usage increased over time towards a peak in the 1980's, and many farmers removed buffer strips from the edges of ditches and streams. Several of these factors led to a decrease in water quality in the region as a whole. Many farmers believed they had a right to farm however they saw fit.

During this time federal farm programs and agribusiness groups combined to focus on fewer and fewer crops. Improvements in farm equipment and this focus on a few crops led to a reduction in the number of farms in the area as average farm size increased over the course of the 20th century.



The Past Landscape Mind Map

INTERVIEWS

Present Landscape

The Present Landscape

Southern Minnesota contains some of the richest, most productive agricultural soils in the world. They are the “Fort Knox” of the Corn Belt region, and influence much of the way that the landscape looks today. Because the soils are so productive, the value of farmland has increased significantly in the last few decades. In order to pay high rental rates and farm loans, farmers must produce high-value products from their high-value land: primarily the corn/soybean rotation, which is the key of the region’s economy. Other high-value uses for the land are organic crops, livestock, and various energy enterprises including wind, methane, ethanol, and biodiesel operations.

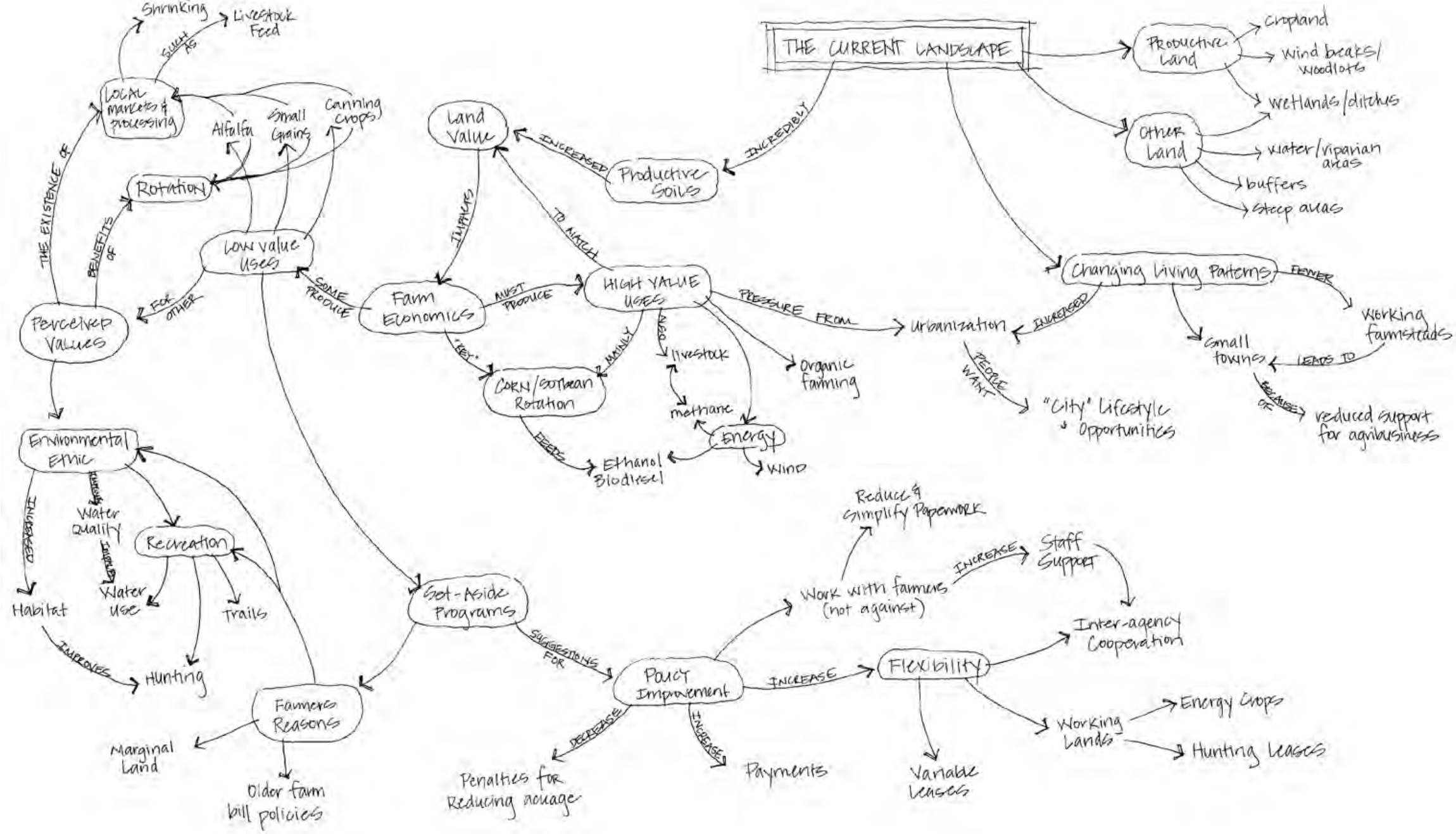
Contrary to the main economic focus of the area, some landowners cultivate products with low economic value from their land because they perceive additional non-economic values in their actions. Farmers grow less-profitable crops such as canning crops or small grains because they value the benefits that the crop rotation brings to their soils. Others grow these crops or alfalfa hay because they have local markets (e.g., livestock operations) or processors that can give them a good price for their crop. However, many processors in the region are consolidating their operations and moving farther away from Madelia and the surrounding towns.

One significant low economic use of the land is environmental set-asides, fields that farmers cease cultivating and typically plant in perennial grasses; although there are many other types of set-aside land. Farmers participate in set-aside programs for many reasons, often because of their personal environmental ethics about land protection. They find that the non-monetary value of improved water quality and wildlife habitat, together with set-aside payments, usually makes such programs worthwhile. Many farmers choose to set aside land that is marginal for annual crop production or land that is especially environmentally sensitive, such as streambank riparian areas. Often farmers enjoy recreation benefits, such as hunting, fishing, and hiking, on their set-aside land.

Farmers who participate in state or federal set-aside programs for land protection have many suggestions for improving the policies that encourage farmers to take land out of production. Their chief desire is for programs that seek to work with farmers, not against them, and offer flexible regulations and higher payments. They want reduced paperwork and help from agency staff in meeting program requirements, as well as flexibility in the requirements for acceptable uses for set aside land. In addition, farmers would like to see programs that do not penalize them for reducing annual crop acreage or lock them in to permanent or long-term leases. In sum, farmers want set-aside programs to increase the perceived value of the set aside land so that it can compete with high-value cash crops in the farm economy.

An additional high-value use for farmland is urban development. As living patterns change and there are fewer and fewer working farmsteads on the landscape, small towns decline as they lose agricultural support businesses. As more people want to live on the fringe of urban areas, with city opportunities but a rural atmosphere, development puts increasing pressure on the region’s rich agricultural lands.

The current landscape surrounding Madelia is primarily productive agricultural land, and people enjoy seeing the land used well and not abandoned. Non-productive areas that are still useful, such as windbreaks, buffer strips, wetlands, and ditches remain an important part of the landscape, as do non-productive set aside areas.



The Present Landscape Mind Map

INTERVIEWS

Future Landscape

The Future Landscape

The ideal future landscape pictured by farmers, Madelia residents, and experts contains many possible characteristics. For the most part, the landscape looks similar to today's agricultural landscape: annual crops will likely continue to make up the bulk of a landscape that is dotted with farmsteads, wetlands, small towns, and woods. The specific features of the landscape, and which parts improve to create the ideal landscape, depend on who is creating the vision of the ideal future.

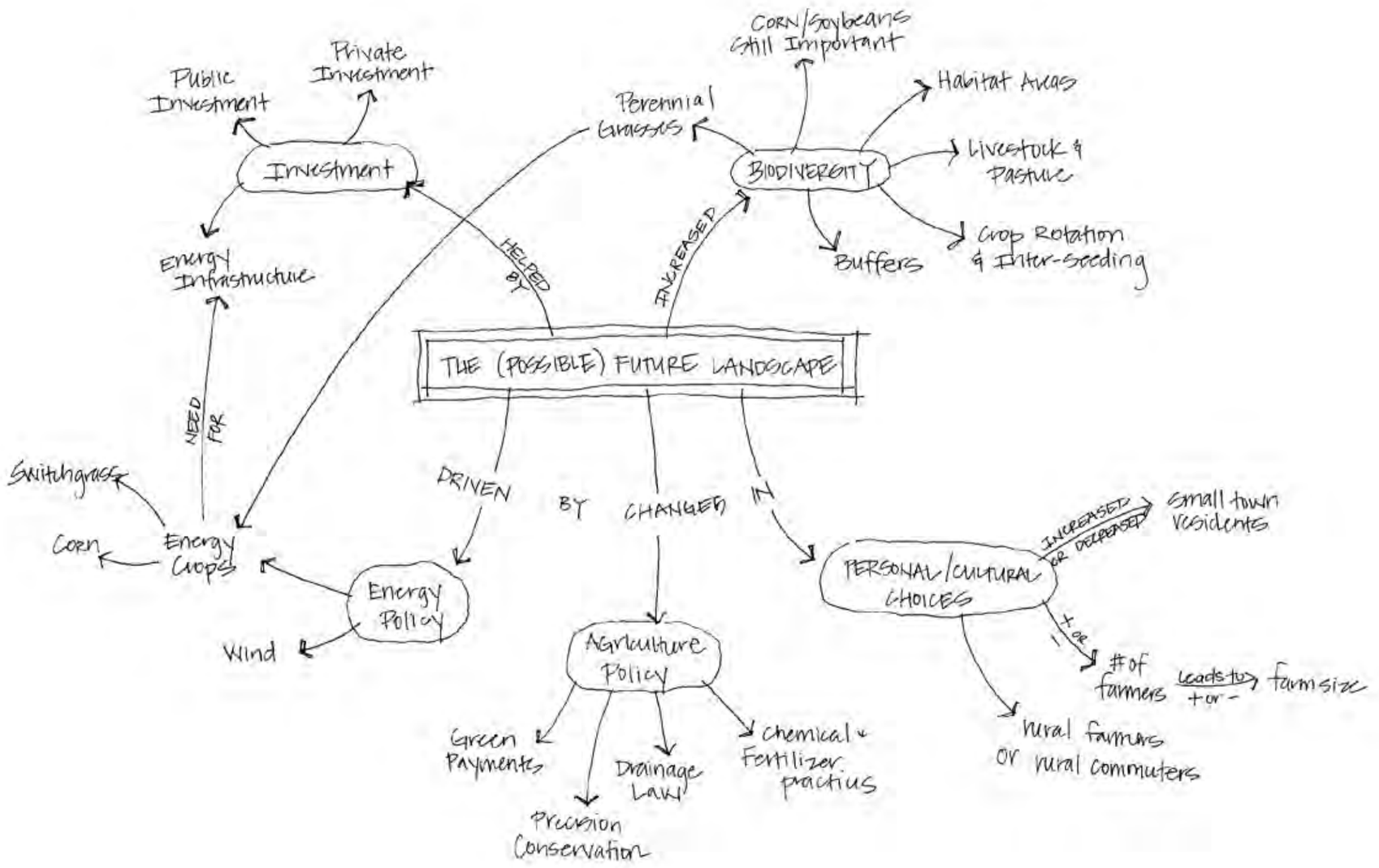
Many study participants, when thinking about the ideal future, envision a landscape with increased biodiversity and increased landscape heterogeneity. They describe a landscape where the sensitive areas are protected and used as wildlife habitat and where all waterways are sheltered by wide buffers of perennial grass. They would like to see more variation in the annual crops, more rotation and interseeding, and more pastured livestock.

In this ideal future, more of the ideal landscape will be used as an energy source for the region and the nation. The Madelia region will continue to produce ethanol and biodiesel, although the ethanol may come from perennial grasses or trees rather than from corn. Wind farms will dot the landscape, producing clean energy to power homes in the area and to sell on the energy grid.

The future will also bring changes in the ways that people interact with the land. If development and urban sprawl continue unabated, the region will be full of people who live in rural areas and commute to regional centers. If farms continue to get bigger and machinery continues to advance, fewer farmers will be able to work and the local economy will become even less dependent on farming. If, however, alternative crops such as energy crops do well, there will be a need for additional labor and additional farmers. Small towns would develop ways to meet the needs of the local energy economy and businesses would locate to the area to take advantage of the available energy and willing residents.

Federal and state policies will play important roles in shaping the landscape of the future in and around Madelia. Changes in energy policy that emphasize and support renewable energy could have a profound effect on the look and feel of the southern Minnesota landscape by encouraging alternative crops or processing. Changes in agricultural policy could provide farmers with the support they need to make important decisions about how they use their land. A national agricultural policy that emphasized so-called green payments rather than commodity subsidies would enable farmers to experiment with energy crops or other non-cash crops. Policies that put serious effort toward cleaning up our nation's waterways could induce farmers to follow precision conservation techniques, change drainage practices, and alter their use of agricultural chemicals.

In order for any of these aspects of the ideal future landscape to come into being, there will need to be significant investment in Madelia and its surrounding region. This investment will likely include improvements in the energy infrastructure, especially if renewable fuels and wind energy continue to expand. Public investment, in the form of tax incentives, cost share programs, and farm subsidies, will fund much work in the area. Finally, private corporations and foundations will need to invest in individual enterprises, pilot projects, and community endeavors in order for the Madelia region to begin to move toward this ideal future landscape.



The Future Landscape Mind Map

SCENARIO 1

Precision Soil and Water Conservation

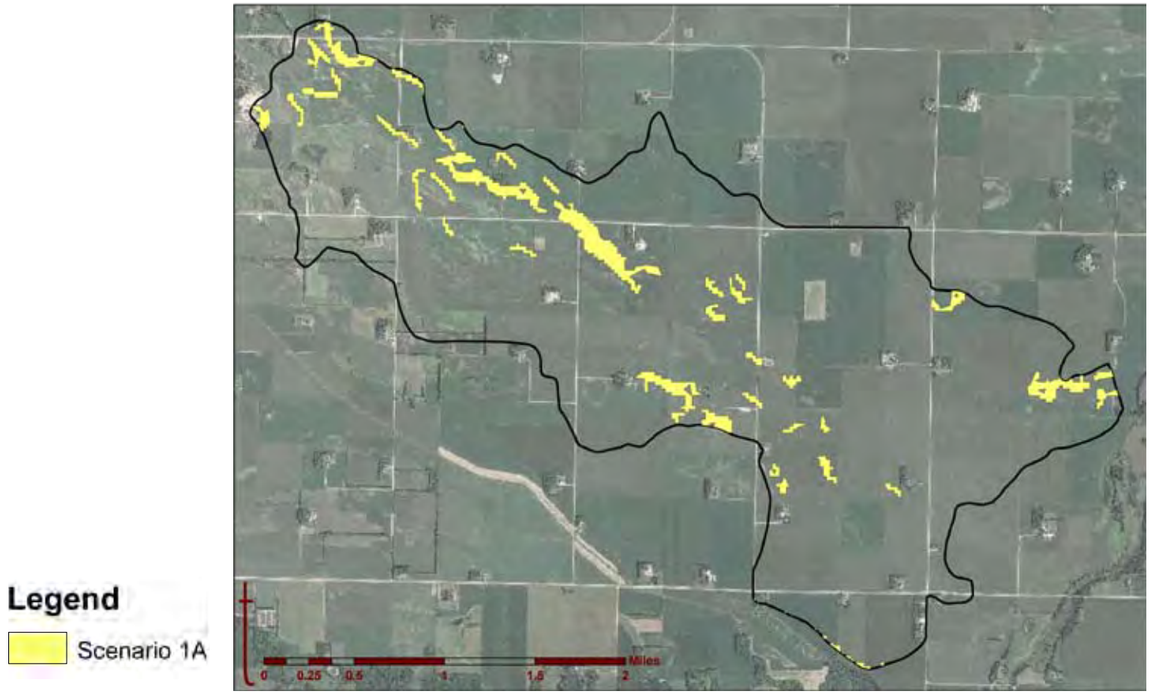
JD-18

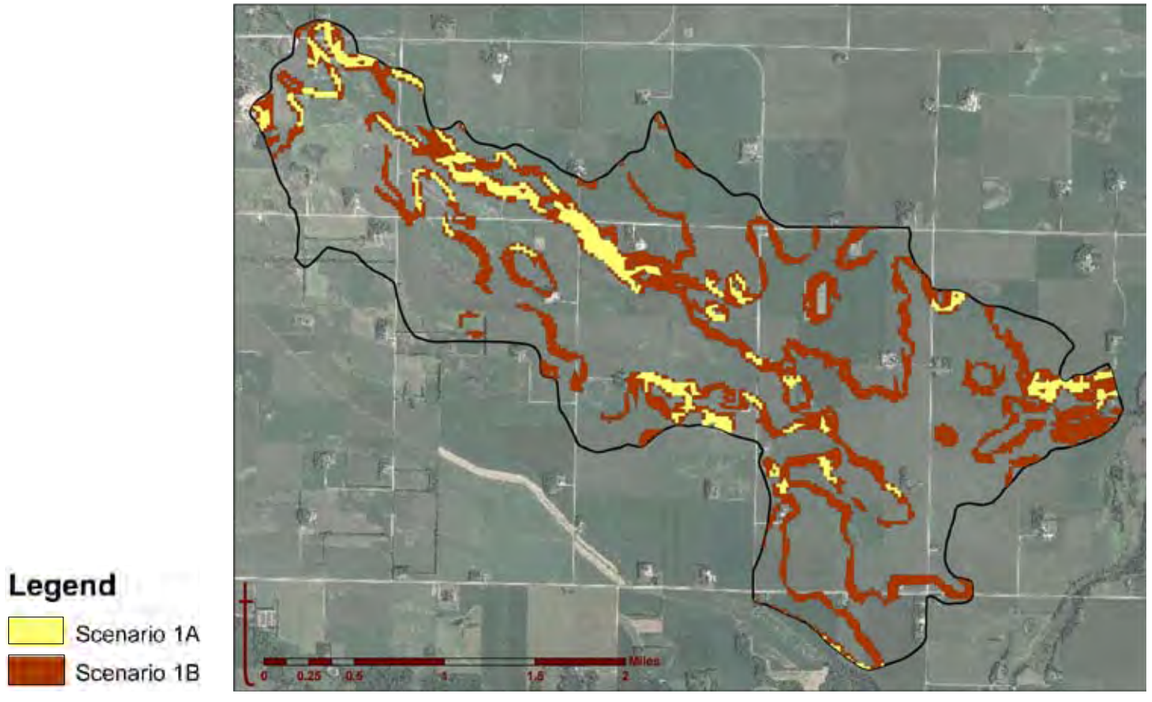
Key Attributes of This Scenario

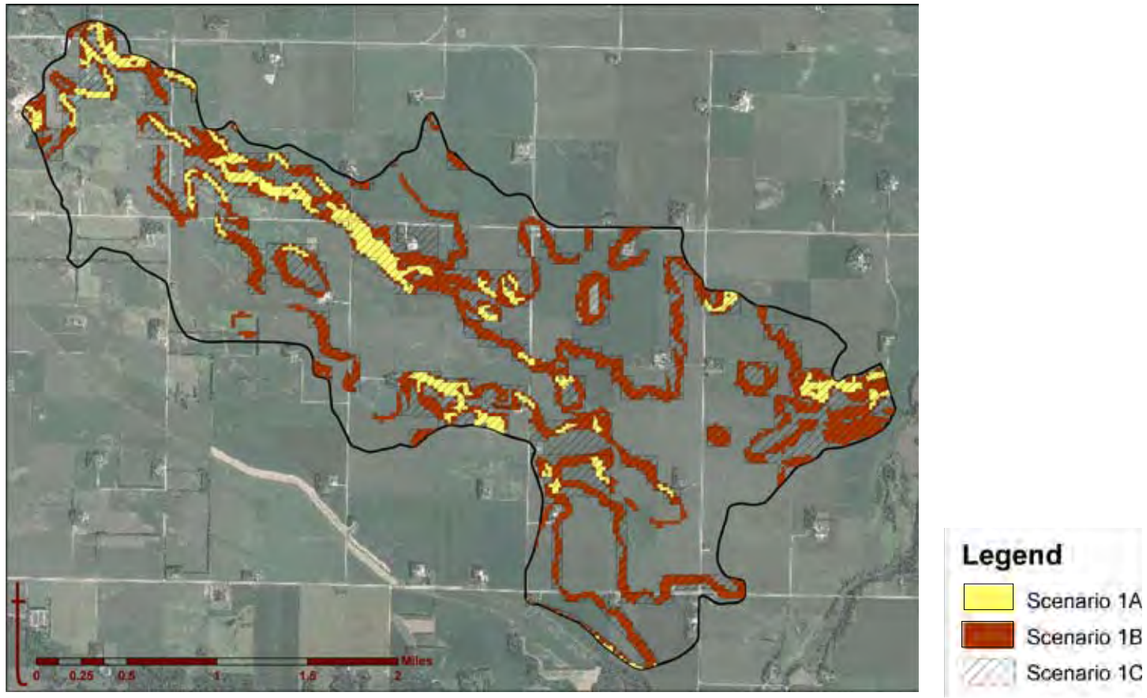
This scenario applies traditional best management practices (BMPs) in a more strategic and integrative fashion, by targeting areas that deserve maximum priority for conservation interventions, and also intensifies emphasis on conservation such as discouraging annual crop cultivation on steep slopes and environmentally sensitive areas. The goal is to push policies of relevant agencies such as Natural Resource Conservation Service (NRCS) and Farm Services Agency toward the strategic approach of conservation investments by 2026. For example, a corridor approach might be taken, aiming to address non-point source pollution more holistically by considering vulnerable areas across the landscape rather than working with land areas on an individual basis. This scenario builds upon past successes in buffer management and related BMP's for water quality and soil protection, including contour plowing, terraces, grass strips, and riparian corridors. This scenario is explicitly based on the Meschke and Perrine draft guidelines for precision conservation. The important assumptions are that landowner buy-in increases for precision conservation land will increase and the land area devoted to conservation increases.

Building and expanding on traditional conservation practices, this scenario assumes that conservation activities are more effective with soil and water protection if they target the most sensitive areas, especially areas with steep slopes and near surface water bodies. In order to create the maps for this scenario, the team produced a map of the surface slope in the area and grouped slopes into five categories: 0-2%, 2-6%, 6-12%, 12-18%, 18+%. Next a second map showing all areas that are within 200 feet of water related features, such as a stream, ditch, lake, or wetland was created. In this particular landscape, slopes of 0-2% and 2-6% are located near streams, ditches, lakes, and wetlands while the steeper slopes are characteristic of better-drained soils and gently rolling topography that are located away from these water related features. By combining these two maps, a composite map of the landscape was created and divided into the following precision conservation categories:

1) 0-2% slopes and 2-6% slopes greater than 200 feet from water related features
2) 2-6% slopes within 200 feet of water related features
3) 6-12% slopes
4) 12-18% slopes; and
5) 18+% slopes







Sub-scenarios

Sub-scenario 1A shows the high priority locations with steep slopes, which are those areas in precision conservation categories 4 and 5 that emphasize soil conservation.

Sub-scenario 1 B adds areas in categories 2 and 3, creating a map showing all priority areas for increased soil and water conservation.

Sub-scenario 1C the landscape patterns that farmers use when putting the ideas of precision conservation into practice, Sub-scenario 1B was used as a guide to draw squared field boundaries for Scenario 1C. The team assumed that existing road right-of-ways and farmsteads will not be part of the precision conservation land, and that farmers will be able to use their fields more efficiently if areas that are not part of the conservation scenario form rectangular blocks. This sub-scenario was drawn by hand and attempted to include all precision conservation areas from sub-scenario 1B that were not excessively small or isolated. Since this sub-scenario involved extensive hand drawing at the scale of JD-18, the team did not include a map at the 10-mile scale around Madelia because of the detailed work required to create such maps, which were beyond the budget and time constraints of this study.

Drivers of Landscape Change:

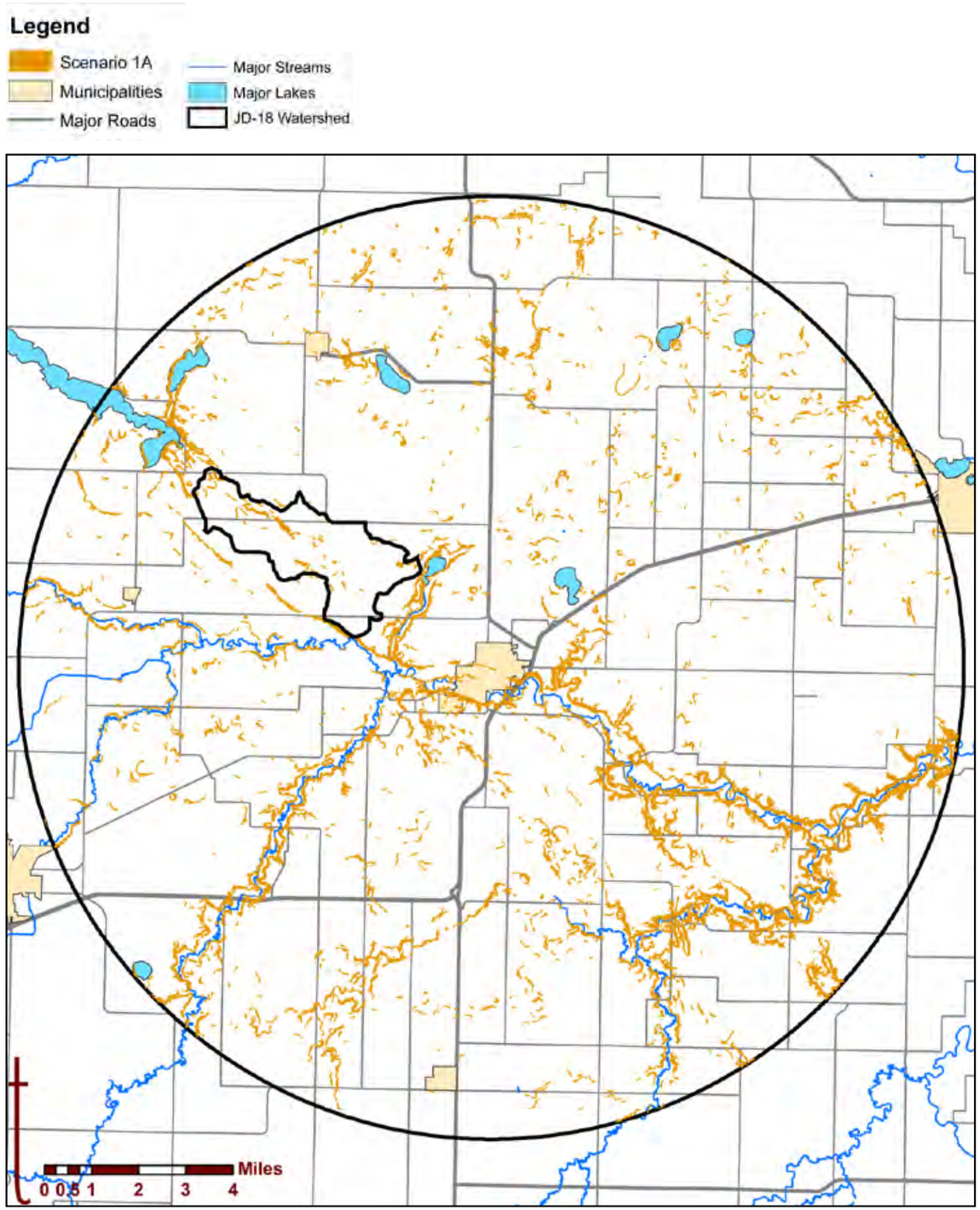
This scenario results from strong emphasis on clean water, total maximum daily load (TMDL) enforcement that involves several key social and policy changes by 2026. The assumption is that current BMPs are not making enough progress on water quality improvement via BMPs. Thus society is willing to pay farmers green payments for more extensive soil and water conservation, and this is the key social value that has changed. A second change in policy priorities place stronger emphasis on protecting soil productivity and crop yields from water and wind erosion, as well as carbon management. The scenario also hinges on strong policy drivers for clean water and soil conservation. The Clean Water Act provides matching funds to address non-point source pollution, through 319 grants and, to a lesser extent, the State Revolving Fund. To leverage these funds Minnesota has created the Clean Water Partnership fund and most recently the Clean Water Legacy Act. The experts that the team consulted noticed a paradigm shift in Minnesota regarding agricultural non-point source pollution and the policy-makers are attempting to develop a plan before litigation becomes an issue. According to our sources, small municipalities are very concerned about costs of compliance with Total Maximum Daily Loads (TMDLs). Therefore, precision conservation initiatives that address water quality from non-point sources can help people deal with TMDL restrictions via voluntary responses to regulations that enlist landowners in innovation and management and avoid rigid top-down regulation schemes controlling farming practices. Some counties already address crucial areas, like riparian zones, through the Continuous Conservation Reserve Program, or Bufferstrip Conservation Reserve Program as it is called in Minnesota. This guarantees Conservation Reserve Program (CRP) contract on a non-competitive basis and the producers do not have to wait until a signup period, which is very popular. Lastly, a reduction in CRP enrollment, and other initiatives that target voluntary retirement of marginal crop land, may be seen as the demand for corn ethanol grows. Many experts

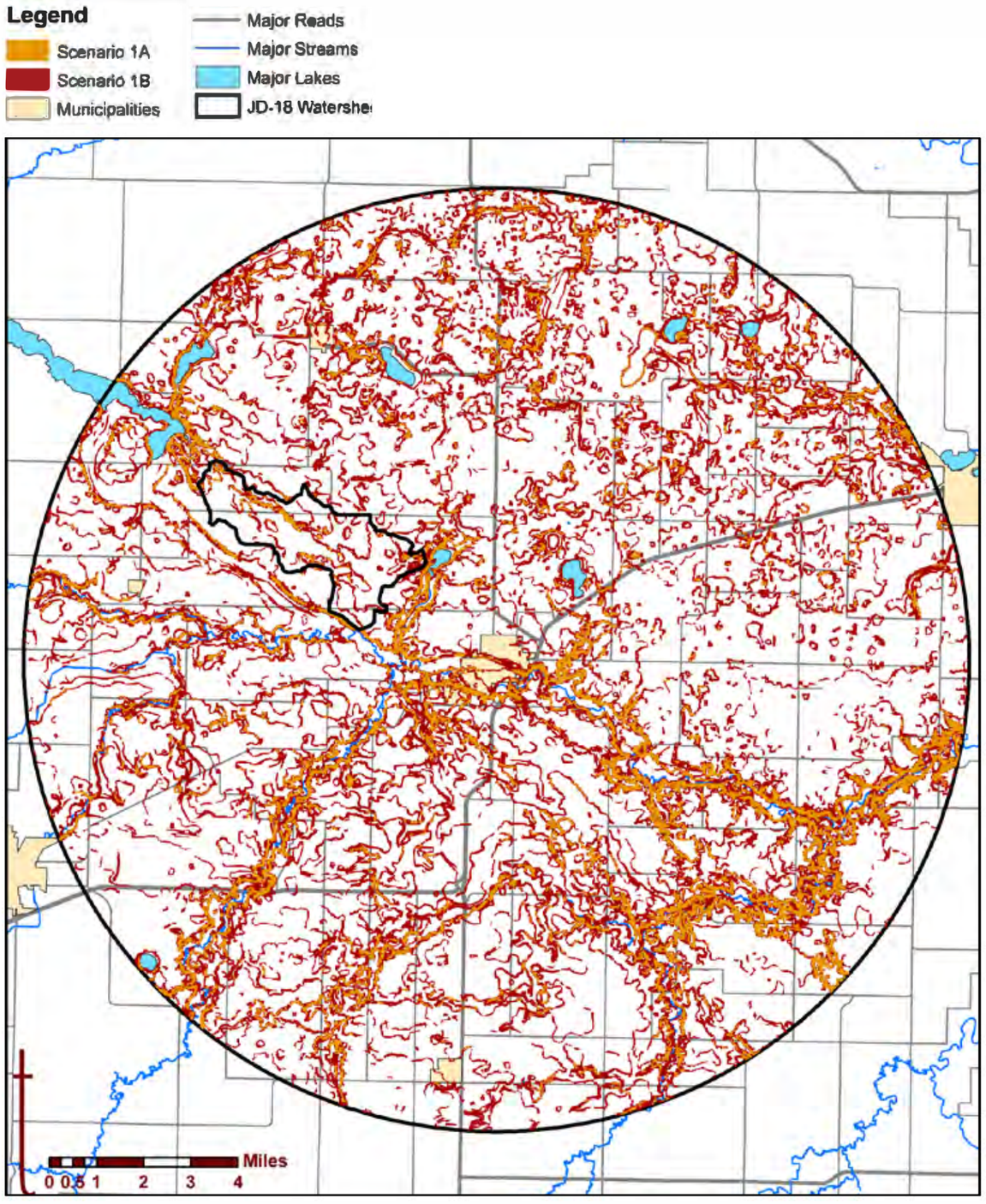
SCENARIO 1
Precision Soil and Water Conservation
10 Mile

note the importance of integrating BMPs and other management guidelines, like precision conservation, as a critical feature of any expansion of annual crop production. It may be possible to create a broad coalition to support increased adoption of precision conservation as a strategy to reduce opposition to corn-ethanol production and meet TMDL requirements in an expanded corn-production scenario, and so on.

Key Environmental, Social, and Economic Benefits of This Scenario
A stronger emphasis on soil and water protection is key and is an important driver for all segments of the farm economy. These conservation goals are seen in the broad context of the Madelia region as part of the Mississippi River watershed. Precision conservation scenarios with emphasis on water quality protection have considerable potential to reconcile agricultural and recreational land uses and defuse conflicts of interest between agricultural and recreational land users.

Important Plant Species and Strategic Planting Locations:
See Table 2: Potential Plant Communities for Madelia Landscape Scenarios in the appendix.




Legend
Scenario 1A
Scenario 1B
Municipalities
Major Roads
Major Streams
Major Lakes
JD-18 Watershe
Miles
0 0.5 1 2 3 4

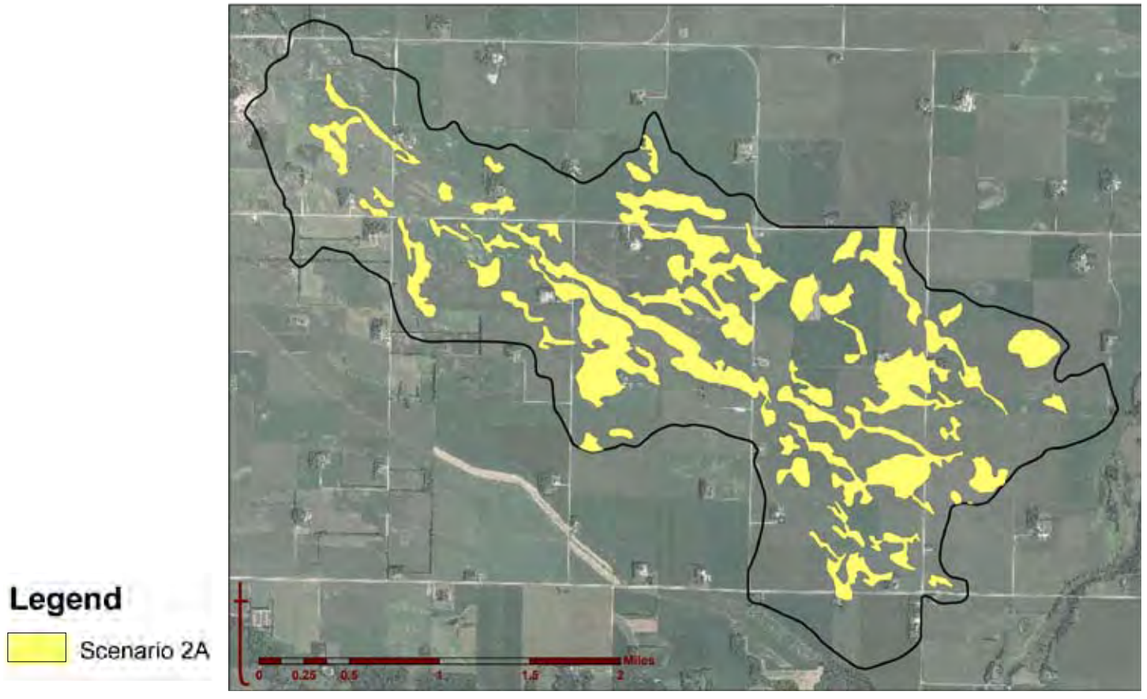
SCENARIO 2
Grassland Biomass
JD-18

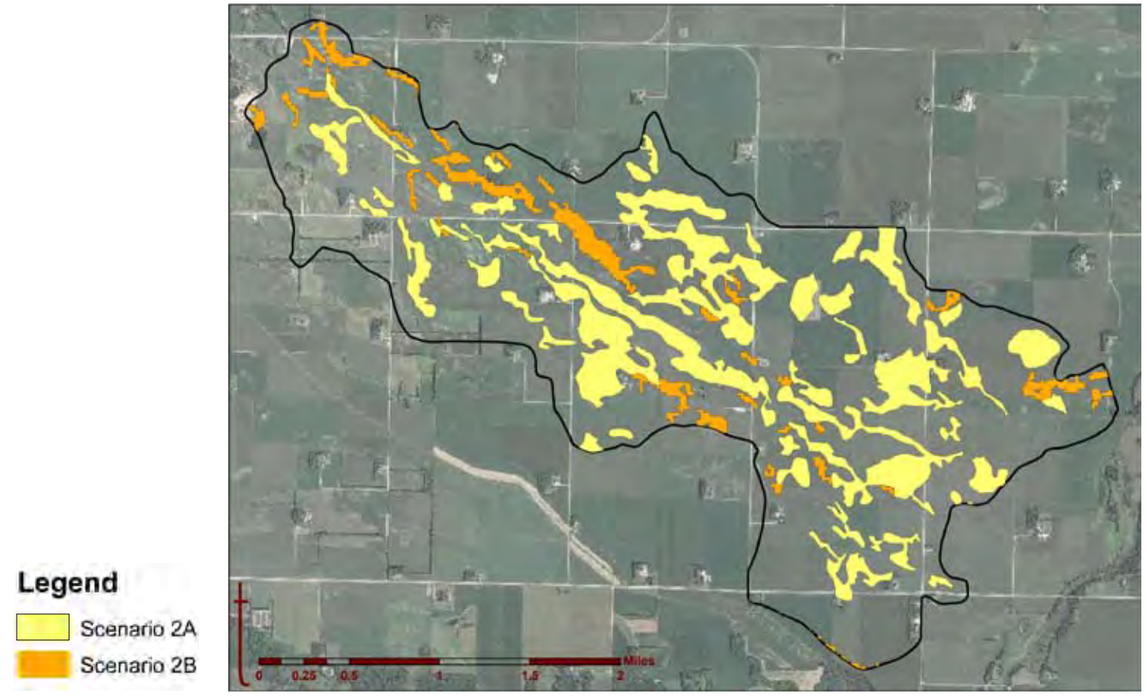
Key Attributes of This Scenario
The grassland biomass scenario takes a step above and beyond the precision conservation scenario by proposing a BMP approach that emphasizes a shift to perennial grassland vegetation by 2026, which may offer significant agroecological advantages in a region once covered by the tallgrass prairie. Corn and soybeans is still the dominant vegetation in the region, but more marginal farmland on wetter and steeper slopes shift to grassland. In this working landscape, substantial new areas of grassland are managed for bioenergy and to a lesser degree for biodiversity and visual quality. It is plausible to for this scenario to occur at time when corn production is expanding for ethanol production while soybean production is decreasing in the region.

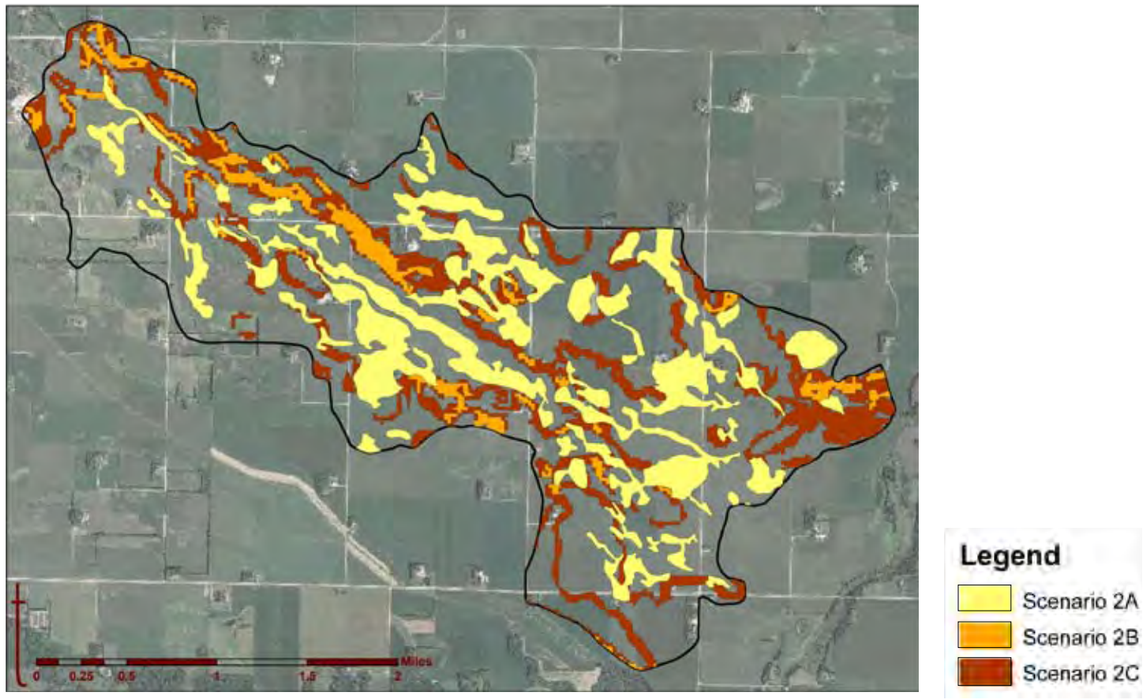
The goal is to produce large amounts of biomass from herbaceous perennials, starting on cropland that is of less than top quality for row crops, then adding steep slopes for additional land for conservation. The maximum-extension of this scenario (sub-scenario 2C) includes creation of square fields that increase efficiency of farm field operations and riparian buffers that incorporate grasslands. Biodiversity conservation is potentially a compatible use in this scenario depending on grass species chosen, harvesting regimes, and so on. For example, grassland management would focus on compatibility with the lifecycle of birds by not disturbing the birds with mowing during crucial times such as during breeding and nesting. The critical issue will be the types of plant species selected and how they are planted and thier value for habitat. For example, this scenario might be realized via monocultures of a grass species; alternatively, prairie polycultures might be another option. Each option has different habitat suitability for birds.

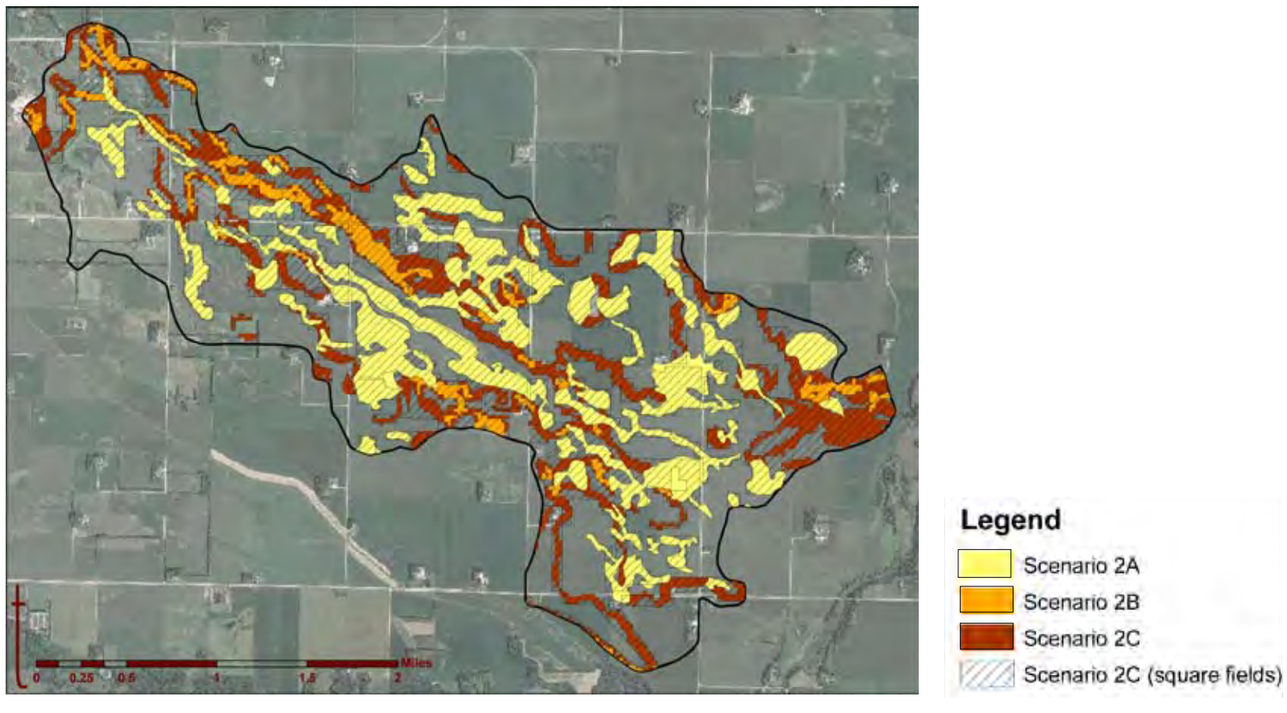
If the use of tile drainage were to be restricted in the future, then this scenario might be quite a bit more productive than row crops in flood-prone non-wetland portions of the landscape, on the assumption that native grasslands, mesic prairie-like communities, will be more tolerant of hydrological fluctuations. We assume that annual crops will continue to be grown on suitably-drained land. At the maximum level, this scenario has many of the historical prairie landscape attributes, with a landscape consisting mainly of grasses. In all versions of this scenario, major changes in farm activities and practices are implicit, particularly because of the labor aspects of dealing with biomass, frequent harvest, and storage issues. Major infrastructure changes will be needed for harvesting, storing, and processing grass biomass. These infrastructure changes would mean new farm infrastructure on farms and new businesses in Madelia to service the needs of new farming practices and crops.

Sib-scenario
Sub-scenario 2A proposes that farmers in the Madelia region begin growing grass crops to produce biomass, the team assumed that









they will initially plant grass species in areas that are at times too wet for annual crops. To show what these areas might look like in the Madelia region, the team used county soil surveys to select all soils that are naturally "very poorly drained". This designation does not consider the effects of artificial drainage, only the properties of the soil itself. The result of this analysis is sub-scenario 2A.

Sub-scenario 2B leaves the best available land for annual crops and to provide the water and soil conservation benefits mentioned in previous sub-scenarios, the team selected highly sloped areas to add to the next scenario. Therefore, sub-scenario 2B includes the soils mentioned in sub-scenario 2A as all land in precision conservation categories 4 and 5 (12+% slopes).

Sub-scenario 2C includes the soils and slopes described above and adds all areas in precision conservation categories 2 and 3, and includes squared field boundaries. As with sub-scenario 1C, one goal of this sub-scenario is to depict ways that farmers could efficiently use the remaining land for annual crops. As before, the team drew the field boundaries for this map by hand so that remaining areas were primarily rectangular. Like sub-scenario 1C, a map at the 10-mile scale was not included because of the detailed work required to create them.

Drivers of Landscape Change: This scenario implies some significant shifts in policy and markets by 2026 to make herbaceous biomass the major productive output of this landscape. One policy change supporting this land-use scenario entails a shift to green payments to farmers that expand grassland production as a bioregional approach to working lands and promote grasslands on landscapes that were once dominated by prairies. Another policy change presumes that society is willing to pay farmers green payments for soil, biodiversity, and water conservation. Like the precision conservation scenario, this scenario also retains productive capacity of soil, manages carbon, and protects soil productivity and crop yields from water and wind erosion. Biodiversity conservation for grassland wildlife in this scenario is potentially moderate to high depending on the spatial arrangement of crops and habitats as well as the types of management regimes.

In interviews, experts highlighted several programs and policies that may promote this scenario. The Grasslands Reserve Program offers rental payments of 10,15, 20 or 30 year agreements, limited duration (30 year) and perpetual easements for landowners willing to voluntarily limit use of grazing land to conservation grazing practices, limited haying, seed harvesting or fire management. The Natural Resource Conservation Service-managed program also has a provision that protects selected nesting bird species and grassland under threat of conversion. Many experts see the expansion of this working lands program as important in promoting perennial biomass crops. The provisions that allow seed harvesting and limited mowing may prove beneficial in harvesting native polycultures for biomass. In addition, land with semi-woody and woody shrubs, such as false indigo, lead plant, and willow, is eligible. The main roadblocks to expanding this program for biomass development are the Grassland Reserve Program funding (which has recently

SCENARIO 2
Grassland Biomass
10 Mile

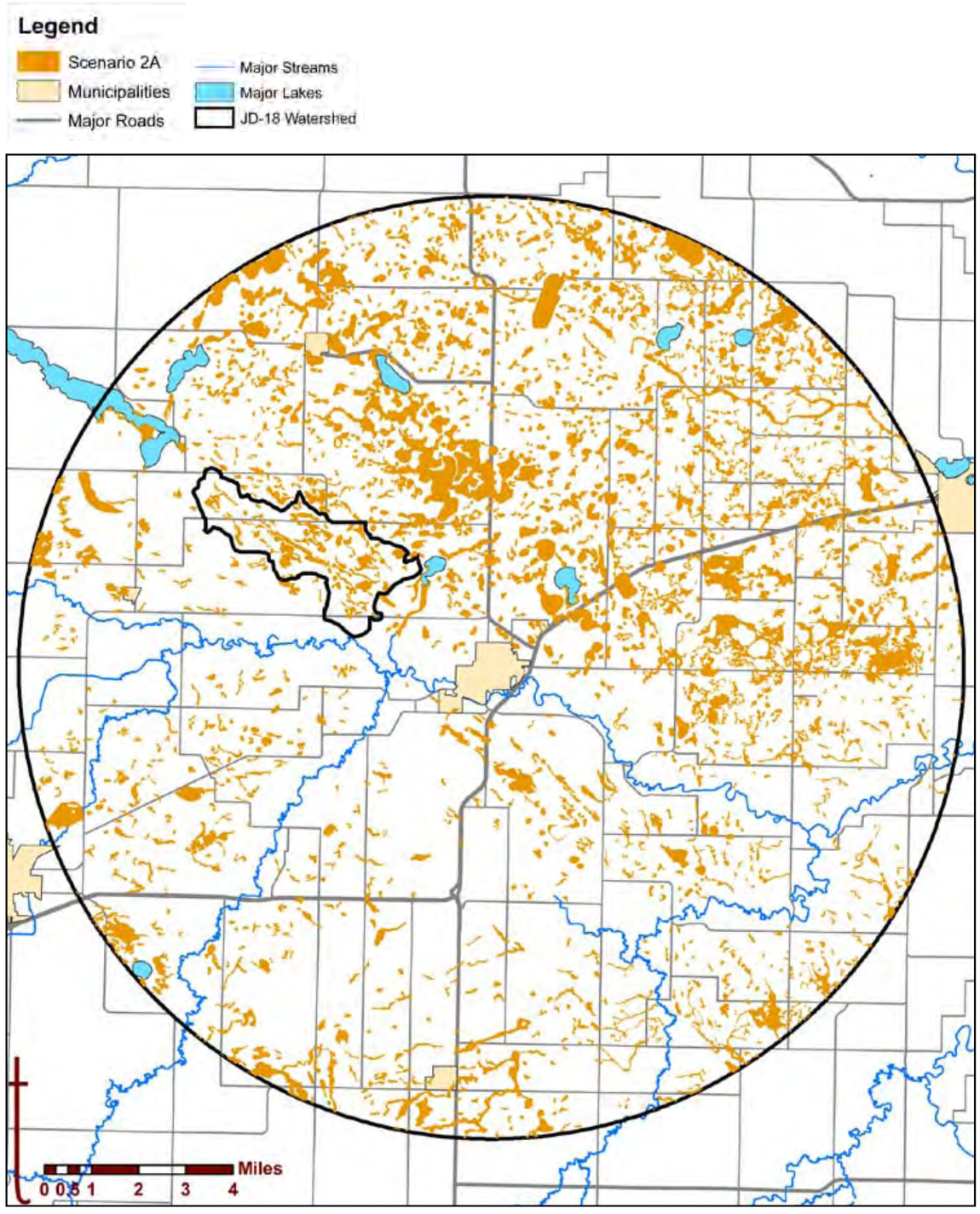
seen increases), producer interest in grassland management, and a field staff that promotes the practices. In addition, other land retirement programs, such as CRP and CREP, with well written contracts may have mid-contract maintenance provisions written into them. This allows participation in Farm Bill programs while providing for some harvest. The main limitation is the program provisions that disallow the marketing of this harvested biomass.

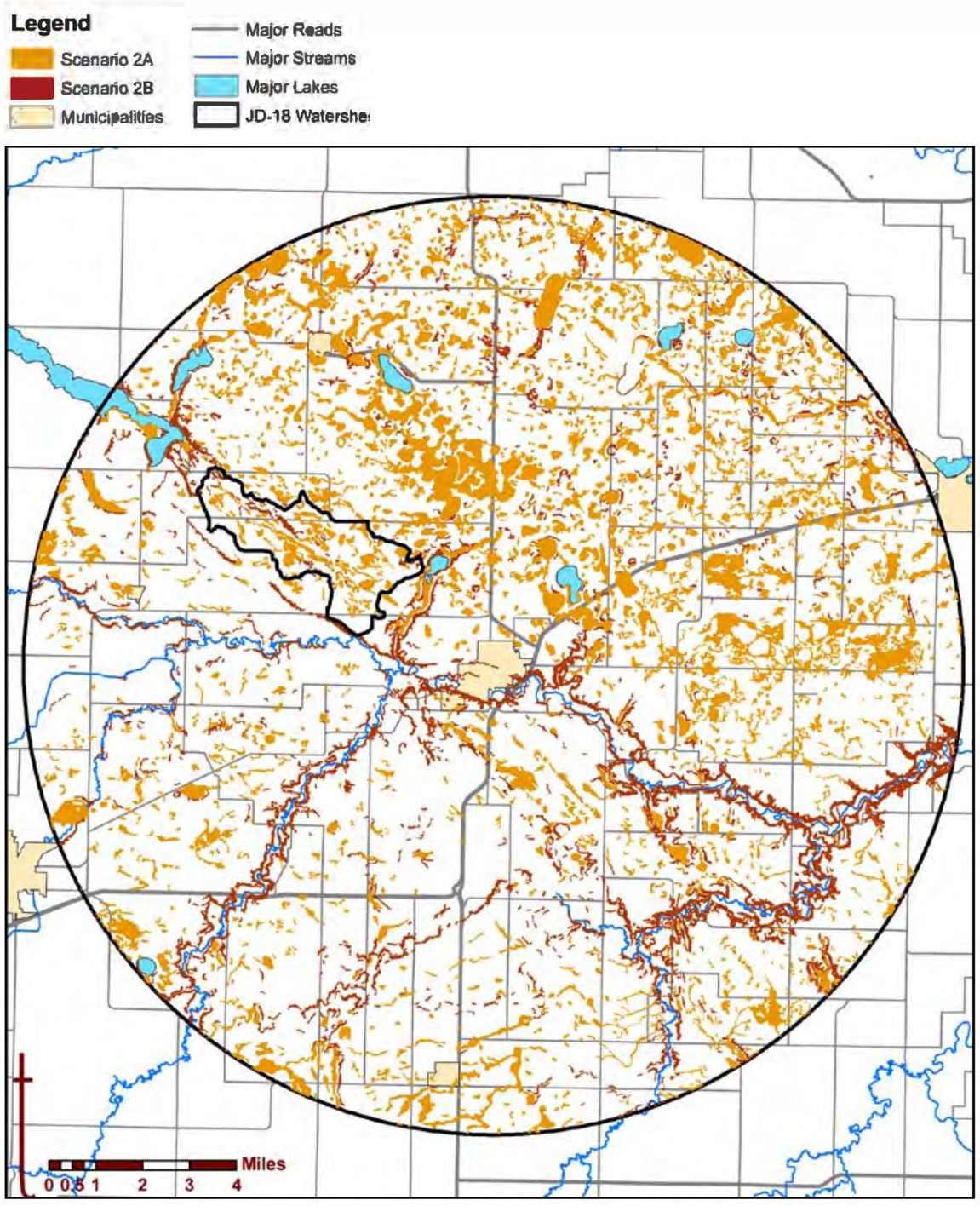
Key Environmental, Social, and Economic Benefits of This Scenario

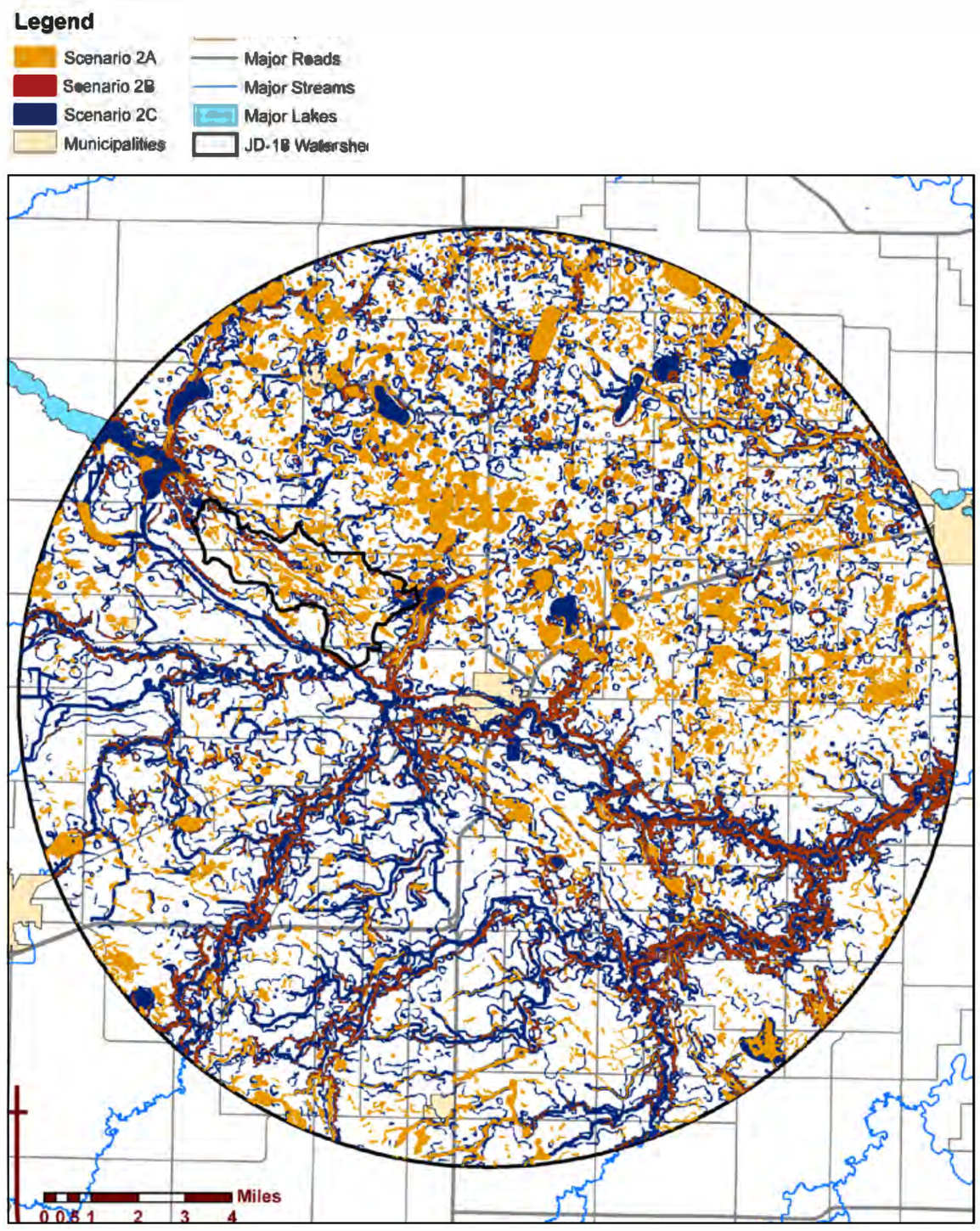
The benefits of this scenario will have the same water and soil protection benefits as precision conservation scenario plus expanded benefits of new bioenergy and biodiversity opportunities. These conservation goals are seen in the broad context of the Madelia region as part of the Mississippi River watershed.

Important Plant Species and Strategic Planting Locations

See Table 2: Plant Communities for Madelia Landscape Scenarios in the appendix.




Legend
Scenario 2A
Scenario 2B
Municipalities
Major Roads
Major Streams
Major Lakes
JD-18 Watershe
Miles
0 0.5 1 2 3 4

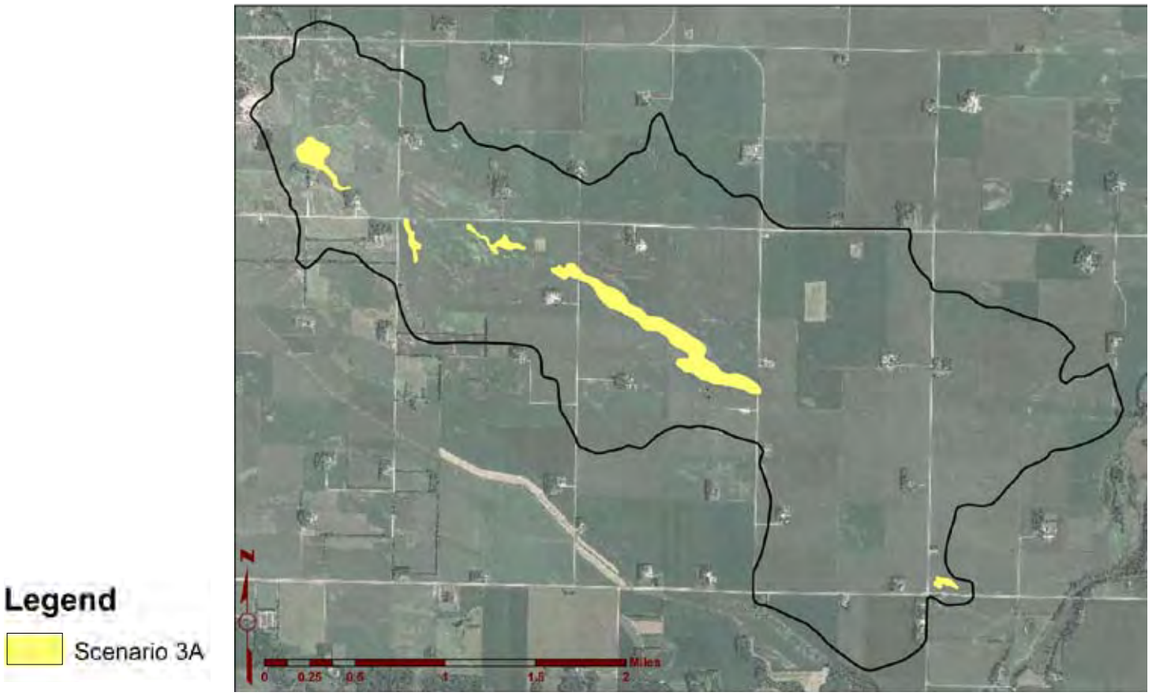

Legend
Scenario 2A
Scenario 2B
Scenario 2C
Municipalities
Major Roads
Major Streams
Major Lakes
JD-18 Watershe
Miles
0 0.5 1 2 3 4

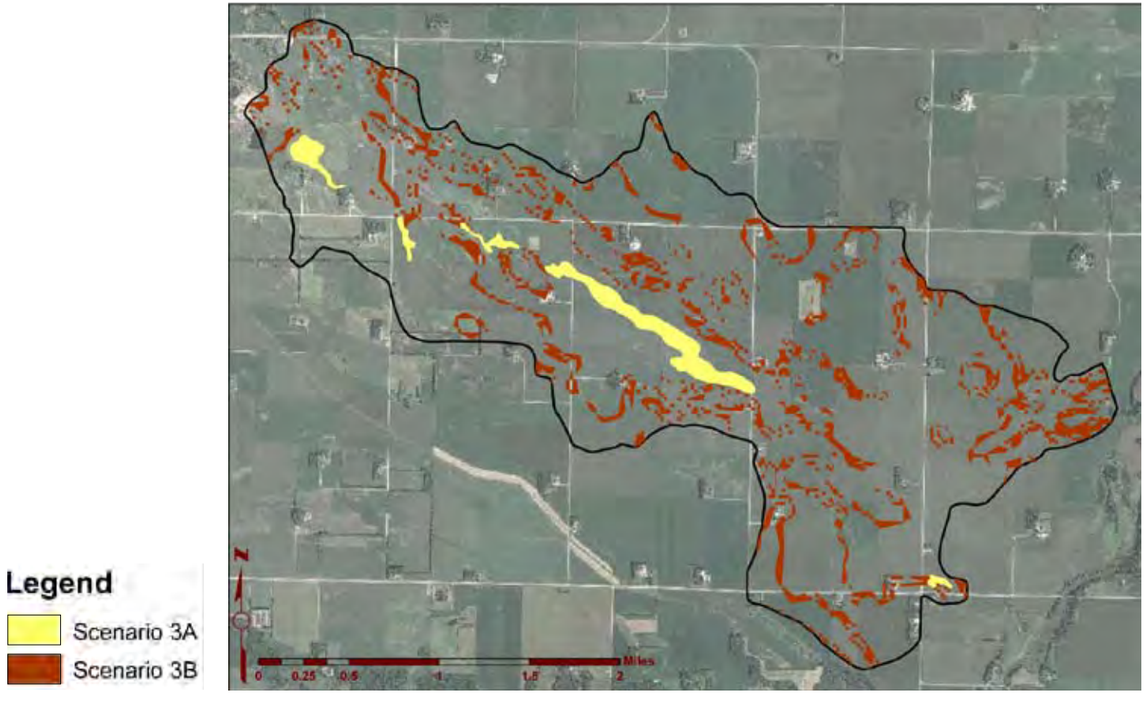
SCENARIO 3
Woody Biomass
JD-18

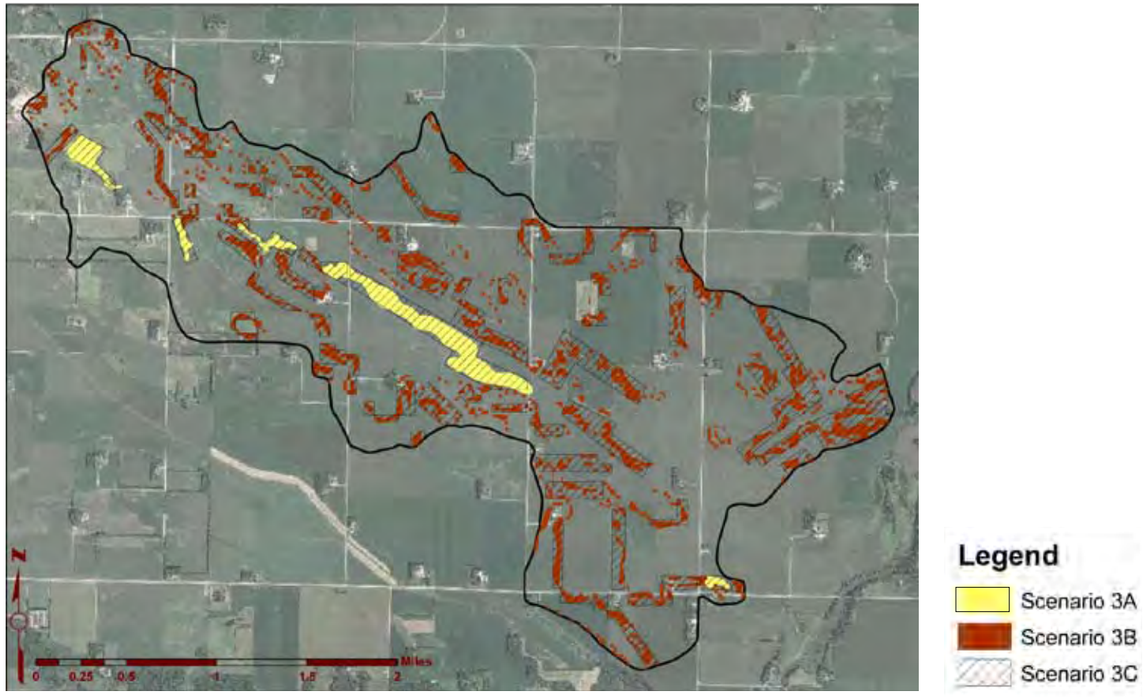
Key Attributes of This Scenario
Rather than expanding grassland patches as the previous scenario, this scenario emphasizes the planting of woody and grassland mosaic in selected areas of the region by 2026. Corn and soybeans will still be the dominant vegetation in the region, but more marginal farmland on wetter and steeper slopes will shift to a mosaic of woody plants and grasses. In this working landscape, new patches of woody and herbaceous plants will be managed for bioenergy and to a lesser degree for biodiversity and visual quality. It is plausible for this scenario to occur at time when corn production is expanding for ethanol production while soybean production is decreasing in the region.

This is a scenario in which trees and shrubs are much more prominent in the landscape than has historically been the case. For example, a plantation landscape pattern in which there are blocks of trees occupying some fields may be created; alternatively there can be plantings in riparian areas, as part of windbreaks, and road right-of-ways. These landscapes would form interconnected networks of small woodlots, grasslands, shelterbelts, riparian corridors, and road verges. Effects of a plantation landscape pattern will differ considerably from those of a network pattern. It is not clear what the effects on biodiversity would be because woody species were not common in this landscape before agricultural development. There may be negative effects on native species adapted to grasslands if this scenario would be established on a large scale, the implications for soil and water conservation would not be entirely clear. There may be considerable erosion in establishment and there would be questions about regional hydrology and changes in evapotranspiration. With proper design, both plantation and network woody biomass plantings can help improve water quality when planted as agricultural buffers along ditches and along field lines. Proposed visual changes should be careful not to alter the flat, open landscape of the plains by fragmenting and interrupting the landscape with vertical plantings along all field edges. Proper visual analysis of the landscape to determine the best location to plant to woody biomass buffers will be necessary.

Major infrastructure changes will be needed for harvesting, storing, and processing woody biomass. These infrastructure changes could mean new infrastructure on the farm and new businesses in Madelia to service the needs of the new farming practices.







An alternative means for farmers in the Madelia region to produce plant biomass is with woody plants, especially willows, poplars, and other fast-growing tree species. The following sub-scenarios have much in common with the grassland biomass sub-scenarios described in the previous section, but the emphasis is on the growth requirements of particular tree crops rather than grasses. This distinction is especially true with regard to wetland soils: while grasses do not grow well in the wetland, willows often thrive in these areas. In order to identify these wetland areas, the team used the habitat suitability rankings in the soil surveys to find soils that are rated “good” for wetland habitat and “poor” or “very poor” for grassland habitat. Further investigation will be needed to confirm the best planting locations that are not in wetlands and other remnant habitats.

Subscenarios

Sub-scenario 3A selects the wetland soil areas as possible locations for willow biomass plantations. The team does not advocate creating willow plantations within existing wetlands because of the negative effects such practices would have on the existing ecosystem hydrology and wildlife. This sub-scenario is intended to represent the diversification of the landscape by planting willows on wetland soils that are currently used for traditional agriculture rather than existing wetlands. Because the team feels that the currently available wetland database does not accurately represent the existing wetlands near Madelia, the team did not attempt to remove existing wetland areas from this sbu-scenario. Further research will be needed to accurately establish the optimum locations for woody plantings in all of these three sub-scenarios that minimize disturbance to wetlands and habitat.

Sub-scenario 3B places poplars in some parts of Minnesota as a biomass crop, and they have potential in the Madelia region as well—although they require conditions different than willows. Poplars need soil that is well drained, and they do well on moderate slopes where they can provide some of the same soil and water conservation benefits as grasses. The team assumed that these trees would be harvested with large tractors that would be limited to slopes of around 10%, so we selected areas with slopes in the range of 6-10% that were not classified as “very poorly drained” for the poplar areas in sub-scenario 3B.

Sub-scenario 3C delineates boundaries around the willow and poplar areas as in previous scenarios—to create rectangular fields for the surrounding annual crops. Like sub-scenarios 1C and 2C, the team did not include a map at the 10-mile scale around Madelia because of the detailed work required to create such maps.

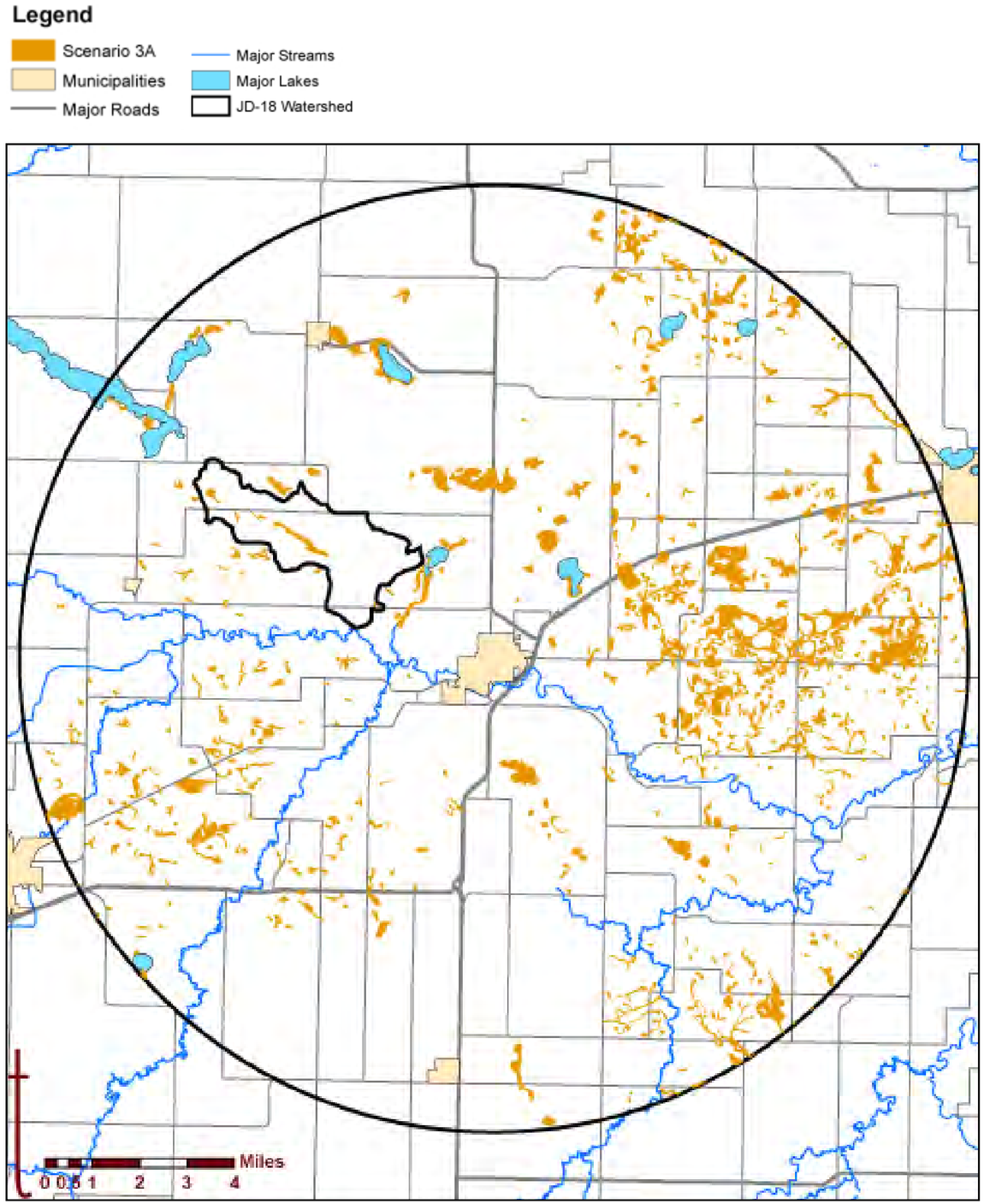
SCENARIO 3
Woody Biomass
10 Mile

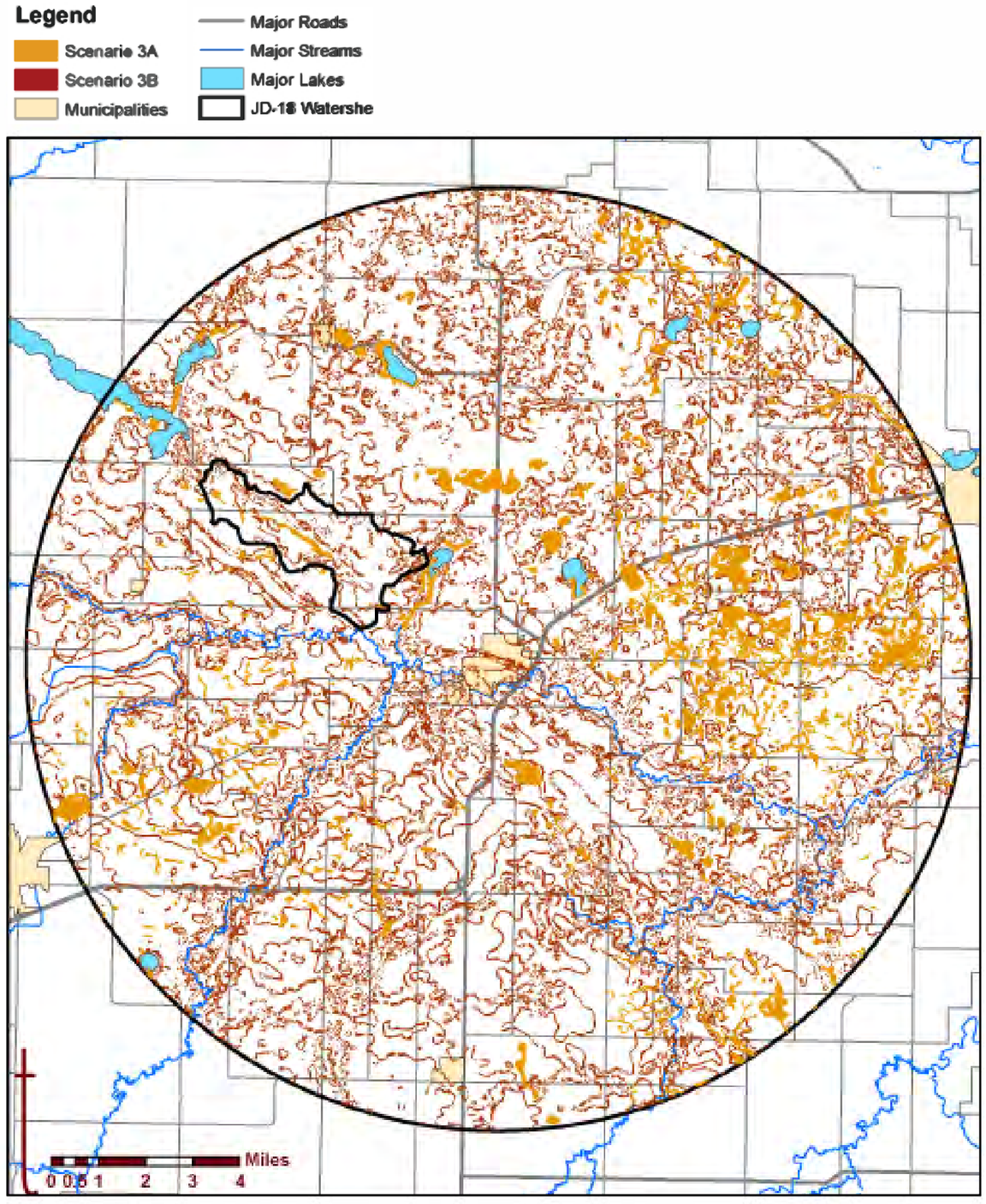
Drivers of Landscape Change Like the grassland scenario, increased emphasis on cellulosic ethanol and other kinds of biomass utilization are central to this scenario. The experts consulted highlighted technological developments as potential drivers, but noted that these developments have not yet exerted major influences on policy affecting land use and agricultural practices. In terms of using woody biomass for ethanol production the main limitation is finding an efficient and economical process to ready cellulose and hemicelluloses for fermentation. The most popular of the options appears to be enzymatic hydrolysis (the other being the more expensive acid hydrolysis) which requires a large investment in finding and isolating inexpensive enzymes. Companies such as Novozymes Biotech and Genencor and government agencies, such as the Department of Energy, are all investing large amounts of money to expedite this process. Any policy that increases development in this enzyme will increase the feasibility of using woody biomass for ethanol production. Co-firing also appears to be an option but Southwest Minnestoa lacks the wood products industry infrastructure that exists in forested regions. However, gasification facilities on scales that support energy needs of rural fuelsheds such as envisioned for Madelia may attract sufficient local support and investment to be implemented. Also, the Farm Bill's Rural Development Title was also mentioned several times in the expert interviews as being a good source of funding.

Lastly, the Conservation Security Program (CSP) would make woody biomass crops more competitive by providing payments for installations along waterways and steep slopes. Most experts see whole-system management programs, such a CSP, as a giant step in the right direction in terms of providing programs that address working lands issues and promote conservation. However, federal funding of the CSP is very limited. In addition, policy drivers will need to overcome risk aversion and cultural concerns about tree farming, such as concerns regarding 10-year and longer times for return on investment by 2026. It is also not really clear how these patterns related to landscape preferences such as where people expect to see trees on the Corn Belt landscape.

Key Environmental, Social, and Economic Benefits of This Scenario
The benefits of this scenario will have the same water and soil protection benefits like TMDL as precision conservation scenario plus expanded benefits of new bioenergy and biodiversity opportunities. These conservation goals are seen in the broad context of the Madelia region as part of the Mississippi River watershed.

Important Plant Species and Strategic Planting Locations
See Table 2: Plant Communities for Madelia Landscape Scenarios in the appendix.




Legend
Scenario 3A
Scenario 3B
Municipalities
Major Roads
Major Streams
Major Lakes
JD-18 Watershe
Miles
0 0.5 1 2 3 4

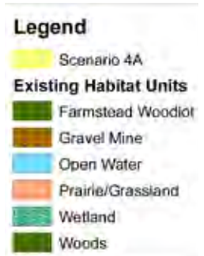
SCENARIO 4
Pride of Place
JD-18

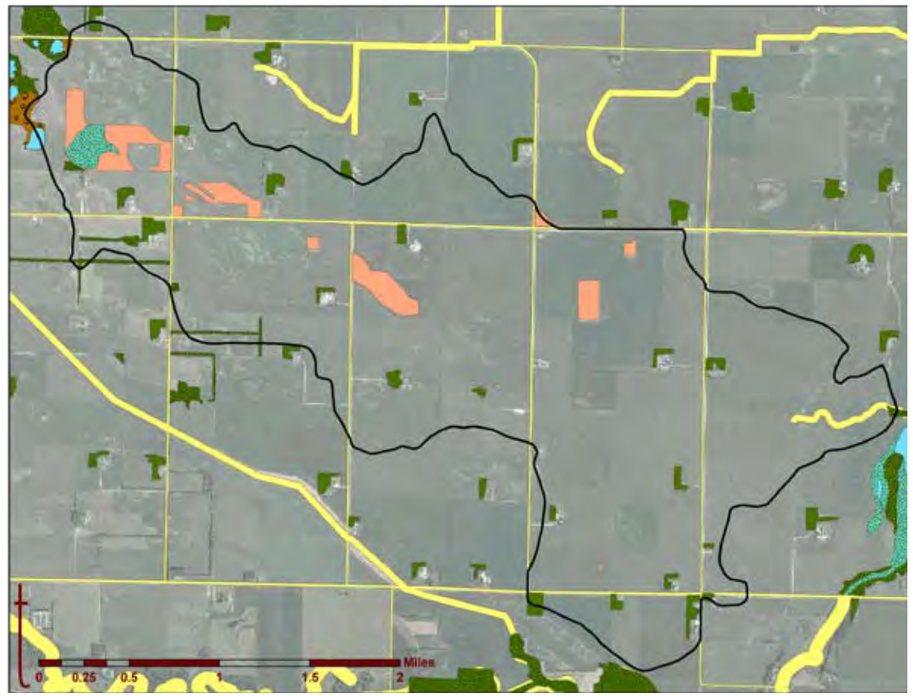
Key Attributes of This Scenario This scenario has a different aim than the other scenarios because it emphasizes the reinvigoration of Great Plains life through the restoration of small towns, habitats and landscapes by 2026. This scenario directly takes on the issue of the human exodus in the Great Plains and parallel decline of rural quality of life by developing a regional strategy to stem rural depopulation. The strategy for this scenario is to recover and reinvigorate what is unique about Madelia like finding beauty in a working landscape of farms and small towns that is often considered of low aesthetic quality. A process of habitat and farm enhancement is needed to bolster the agritourism and biodiversity potential of the Madelia region. The premise is that a beautiful and productive landscape will attract people to move to Madelia for its high quality of rural life and attract ecotourism and agritourism.

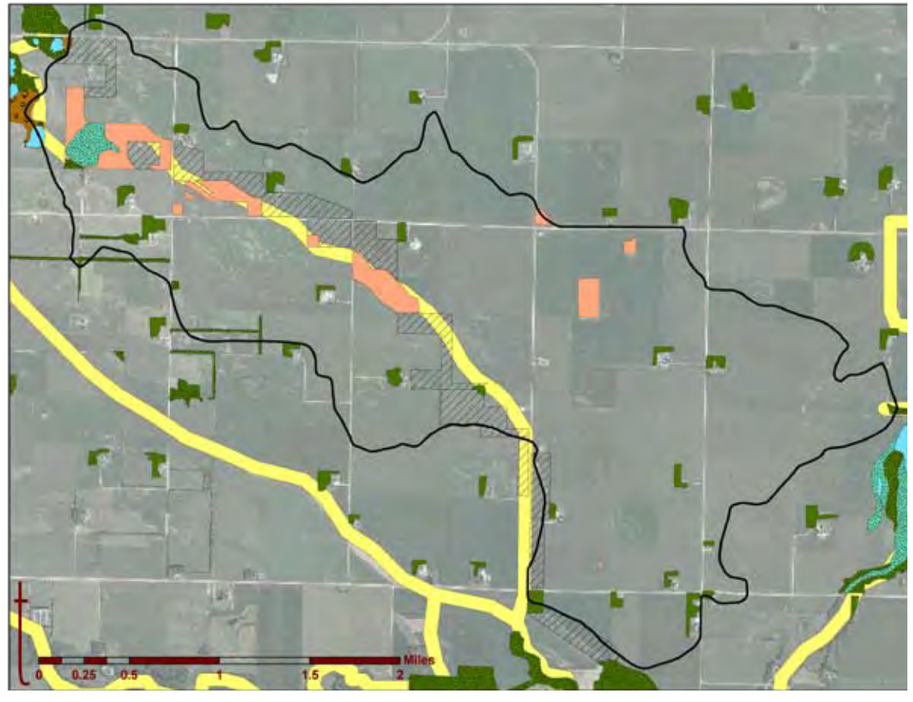
The proposed land-use changes under this scenario aim to add conservation value to the region by enhancing existing non-annual crop land use and prioritizing using steep slope areas for land use change. Corn and soybeans will still be the dominant vegetation in the region, but more marginal farmland on wetter and steeper slopes as well as areas suited for prime grasslands will shift to a mosaic of habitats. In this working landscape, new patches of habitat will be managed for biodiversity and agritourism and to a lesser extent for bioenergy. It is plausible for this scenario to occur at time when corn production is expanding for ethanol production while soybean production is decreasing in the region.

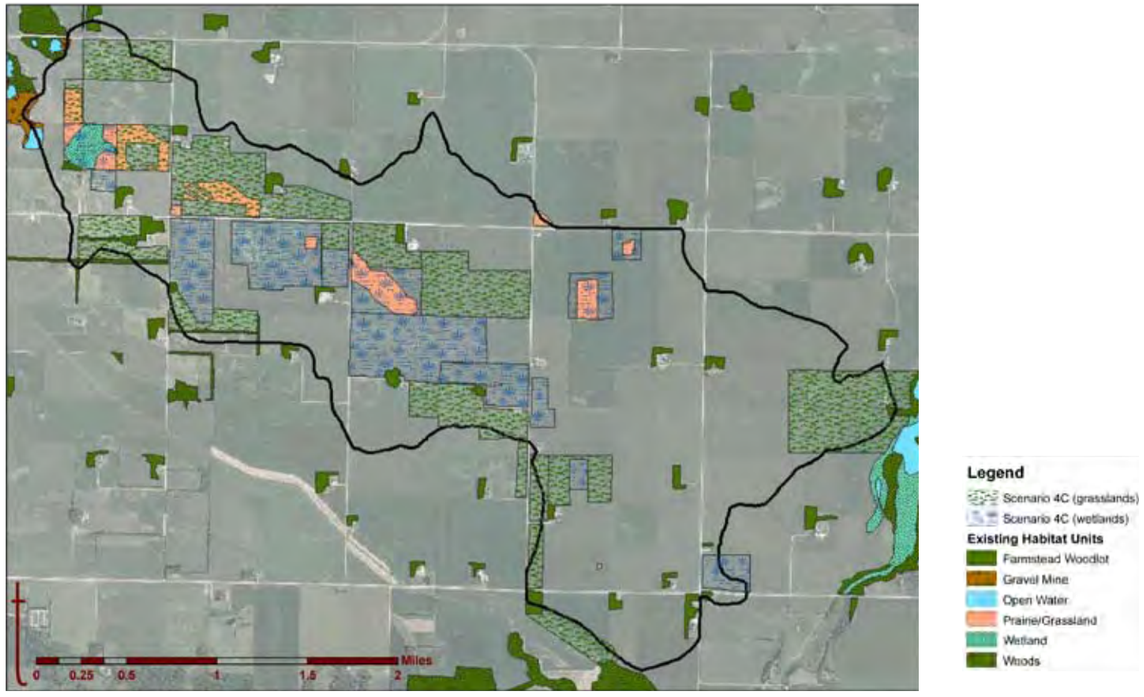
In this scenario, the sizes of certain landscape patches are somewhat arbitrary because the requirements of particular species of conservation interest have not been specifically defined. There may be significant opportunities for increased income through leasing hunting and fishing, as well as enhanced recreational land use that is leveraged by development of striking landscape features and scenic byway development, and so on. Aesthetic value of the landscape could be enhanced with features like plantings along roadways (e.g., prairie restorations on road verges and stream crossings) where small areas can enhance visual quality and sense of place.

In creating this scenario the team used different methods for the 10-mile scale and JD-18 scale. At the JD-18 scale, the team was able to draw upon knowledge of the site and existing habitat conditions, as well as the slopes and soils in the surrounding area. The team created a map of the existing habitat units at the JD-18 scale from recent Farm Services Agency aerial photos and information from our site visits. This knowledge allowed selection of areas for potential aesthetic, recreational, and habitat enhancements that fit well with the existing land use in the watershed as well as the complimentary goals of soil and water conservation. At the 10-mile scale the team was not able the perform analysis with this









level of detail because of to time and budget constraints. In order to show what these scenarios might look like at this broader scale of 10-miles, the team used a readily available land use map (Minnesota's 1990 Census of the Land) to select existing habitat units, which we defined as all land uses that are not urban, row-crop agriculture, or gravel mining. A major goal for habitat enhancement in this scenario was to increase the connectivity of habitat corridors and large habitat patches by 2026. In addition, the visual diversity of the agricultural landscape is enhanced while respecting the regional landscape character of Madelia. An example is the enhancement of habitat along road right-of-ways through new native plantings that would increase habitat value for different animal species and aesthetic appeal for local residents and visitors.

Subscenarios

Sub-scenario 4A adds wildlife habitat to an agricultural landscape and uses the road verges that are currently covered by perennial and annual vegetation. For sub-scenario 4A the team delineated the existing road rights-of-way for all state, county, and township roads as well as all railroad rights-of-way within 10 miles of Madelia. To perform this analysis the typical right-of-way width was estimated for various road classes from aerial photos and then created buffers over the existing roads. In order to give this sub-scenario additional wildlife and soil conservation benefits, the team included buffers of 100 feet around intermittent ditches and streams and 200 feet around perennial streams in the region. These buffers serve to create corridors and further connect the road right-of-way habitat. The JD-18 and 10-mile maps show identical layers for this sub-scenario.

Sub-scenario 4B draws on knowledge of the habitat types already existing in the region's landscapes. For JD-18, the team defined a habitat element as any grassland, woodland, wetland, or lake regardless of its size. The team drew additional corridors of habitat to connect the existing habitat areas, assuming that the wet and steep areas identified in the previous sub-scenarios would be good set-aside habitat areas. The resulting map does not represent habitat that is targeted to any specific species, but rather one possible system of continuous habitat connecting Lake Hanska and the Watonwan River through the JD-18 watershed. At the 10-mile scale, the coarser-scale land use maps were used to identify existing habitat elements and to sketch out possible habitat corridors. Using these lines as a guide, habitat corridors with a minimum of 200 feet width were created.

Scenario 4C. Some Minnesota agencies, most notably the Department of Natural Resources, have suggested that a potential goal for habitat enhancement in southern Minnesota would be to create areas that are approximately 20% grasslands and 20% wetlands. In order to envision what this level of habitat restoration would look like in the JD-18 watershed, the team used many of the techniques and tools from previous scenarios to create sub-scenario 4C. The team drew blocks of wetland habitat on wetland soils, many areas of "very poorly drained" soils, grassland habitat on steep slopes and locations that connected with other habitat blocks. The team sought to make the resulting habitat blocks large, connected, and with rectangular field boundaries so that the remaining agricultural land could be used effectively and efficiently. Because of the landscape condition of the JD-18 watershed, the team was not able to create fully 20% wetlands, but the resulting map shows some of the areas that would have good potential for habitat enhancement in this extreme scenario. Because of the detailed work and site knowledge necessary to create this map, the report does not include a map of this sub-scenario at the 10-mile scale.

SCENARIO 4
Pride of Place
10 Mile

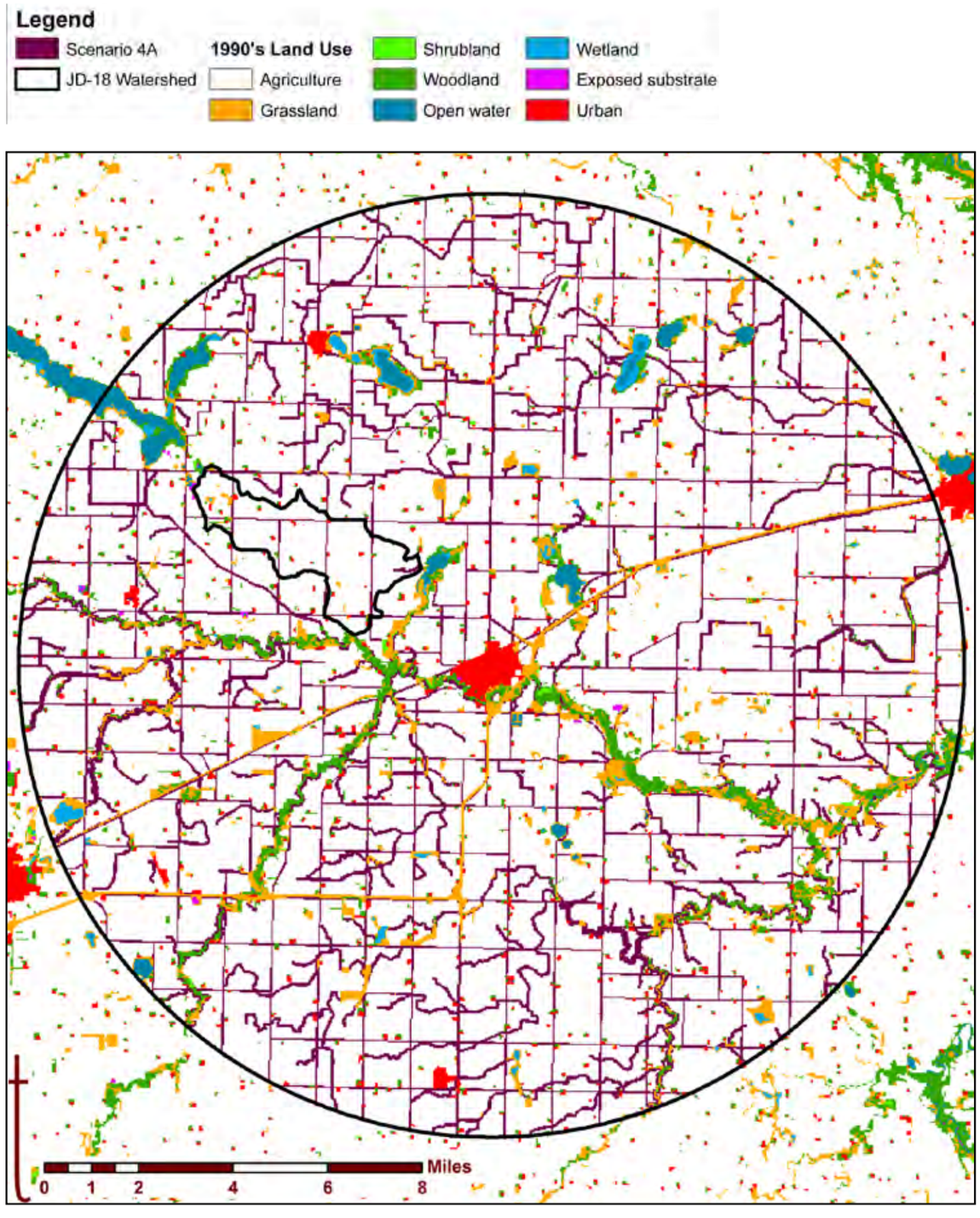
Drivers of Landscape Change:
This scenario depends on changes at the local and regional scales. For example, residents of the Madelia region might decide to be a cutting-edge example of a reinvigorated Great Plains community by 2026. A new initiative might be put in place for residents to rediscover the unique attributes of their region-- a treasure trove of history and experiences that are rooted in their enduring relationship of their agrarian roots with the land and nature. An agritourism group might be established to develop and promote the tourism and recreational qualities of the region. One potential strategy is scenic agricultural byways program.

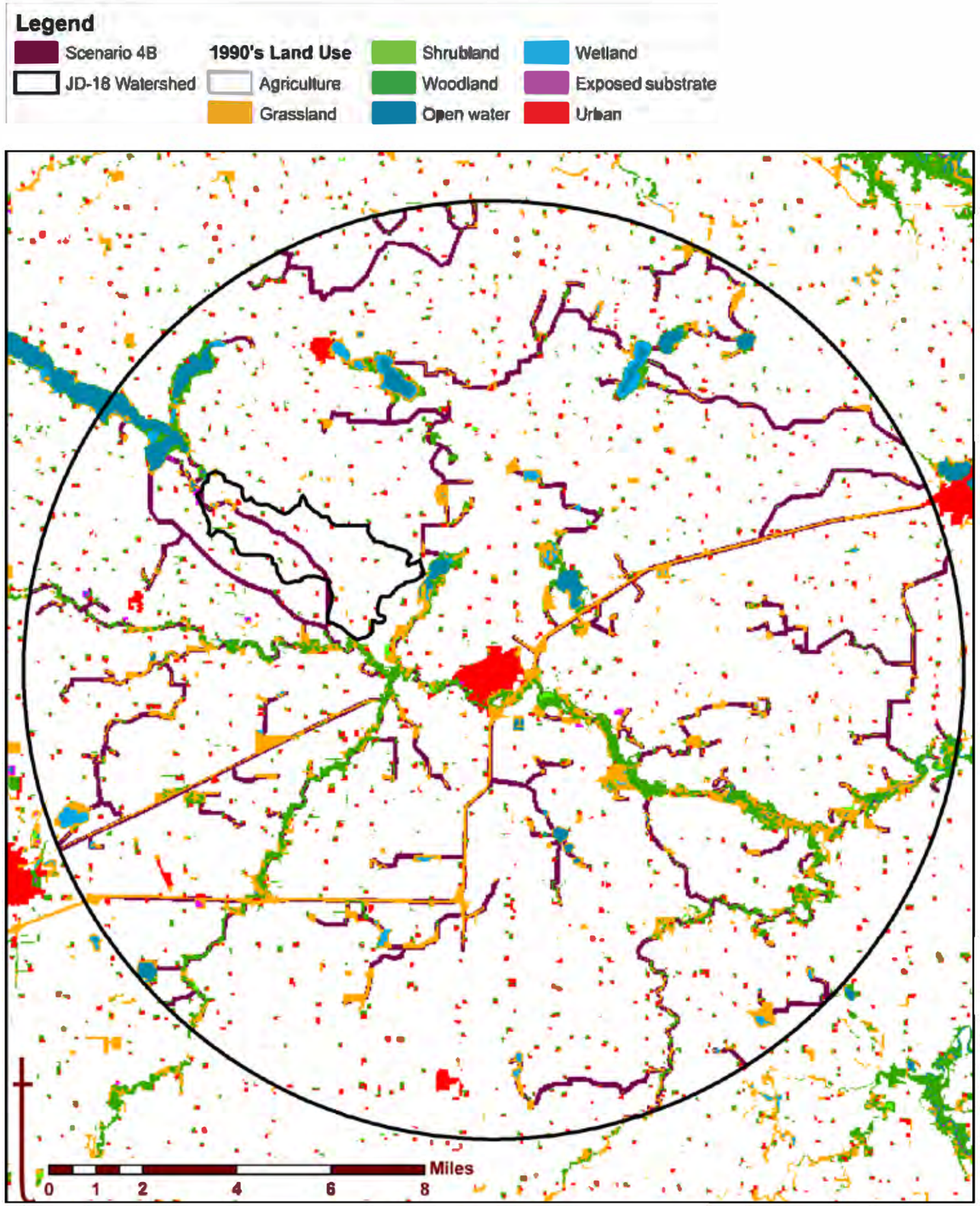
A second driver arises from a broader trend: wildlife conservation groups have managed to gain more political influence and have become focused on a concept of working land as being of key concern; also state agencies have increased support for conservation on private lands. Nearly all the Farm Bill conservation programs provide for wildlife habitat in their language. However, new Farm Bill provisions addressing biomass crops compromise wildlife habitat. The experts indicated that wildlife interests are working hard to get provisions that address habitat under biomass production enhancement scenarios. These groups are reportedly very concerned by proposals to allow partial or mid-contract biomass harvests on conservation lands (e.g., CRP).

In global trade negotiations, there is growing pressure on the United States and the European Union to reduce agricultural subsidies which include Farm Bill programs such as Conservation Reserve Program (CRP), Environmental Quality Program (EQIP), and Wetland Reserve Program (WRP). However, so-called green box subsidies have been recognized, which allow payments to farmers who provide environmental services; the Conservation Security Program would fit into this green box of less-controversial subsidies.

Key Environmental, Social, and Economic Benefits of This Scenario
The primary focus is enhancing the biodiversity and aesthetic potential by promoting the economic, community, and environmental health of the Madelia region. Secondary benefits include water and soil protection

Important Plant Species and Strategic Planting Locations:
See Table 2: Potential Plant Community for Madelia Landscape Scenarios in the appendix.




Legend
Scenario 4B
JD-18 Watershed
1990's Land Use
Agriculture
Grassland
Shrubland
Woodland
Open water
Wetland
Exposed substrate
Urban
Miles
0 1 2 4 6 8

CONCLUSION

Concluding Remarks
In this report, the team presents a pilot study that focuses on the alternative futures for the perennialization of the Madelia region's landscape; with the goal of enhancing the region's potential for biofuel production, habitat protection, water quality protection, agritoursim, recreation, and scenic resources. The study is a first attempt to address the complex nature of landscape and economic diversification in a region with only two major crops, little public land for habitat enhancement, and a small industrial base. The study was structured to be an applied, community-based project, and not as an empirical research project, for two reasons: because of the need for practical information for the Madelia group led by Linda Meschke and the student researchers' interest for professional interdisciplinary experiences. It is important to remember that this study cannot answer all of the questions about the potential of landscape perenialization and biofuel development in the Madelia region because the project budget was small and lasted only for the summer of 2006. The team has many questions that it would like to pursue in the future. For example one potential direction will be to look at the potential of road right-of-ways for biofuels, wildlife habitat, and scenic resources (Musacchio and Koepke, 2007).

The Next Steps
The Madelia Model, which is spearheaded by Rural Advantage's Linda Meschke, is working to develop business plans that can be used to guide and raise capital support for ongoing efforts to pursue new economic opportunities based on sustainable bioeconomic development. Also, an engineering analysis and biomass inventory have identified a generation technology, gasification, as most appropriate for a renewable energy production facility at Madelia. The scenarios detailed in the report are intended to support the Madelia Model's planning process that will engage multiple stakeholders in a learning group that will facilitate collective learning and collaborative action for sustainable bioeconomic development. The scenarios will enable more detailed and systemic consideration of a multifunctional landscape surrounding Madelia. Previously, the nature of this landscape had only been generally described, with little specification of the scope, range and nature of realistic scenarios by which this landscape might be realized. The study outcome defines several of these scenarios in considerable detail, offering a key input for planning and development efforts for the Madelia Model.

Any statement of conclusions from these scenarios is entirely premature, as the scenarios are principally intended as a tool to support systemic thinking about sustainable bioeconomic development in the Madelia region, by individual stakeholders and by multistakeholder groups. However, the team offers several preliminary observations concerning implications of the scenarios:

1. Given plausible policy-changes scenarios, a large proportion of farmland in the Madelia region is better suited to cultivation of perennial crops. This finding is perhaps surprising, given this region is renowned for production of annual field crops. The maximum-implementations scenarios depicted in our report indicate that 25-50% of the landscape favors perennial crops. Under these scenarios, the implementation of effective multifunctional landscapes may be

considerably facilitated. For example, the particular interests of many stakeholders may be more easily met, with fewer tradeoffs, in a landscape where a large fraction of land area is devoted to perennial crops and managed plant communities.

- For Madelia Light and Power and other renewable-energy production interests, there is potential for a high density of biomass production in the landscape around Madelia. This potential reduces transportation and handling costs for biomass energy production; these costs are major constraints to biofuel production.

- For Minnesota Department of Natural Resources and other wildlife and biodiversity interests (e.g., Pheasants Forever, Ducks Unlimited, Izaak Walton League). The high density of perennial crops potentially providing high-quality habitat for species of conservation interest may mean that there is considerable leeway to harvest biomass and perform other management actions without major tradeoffs with wildlife conservation and wetland/riparian protection. However, further research will be needed to determine the optimum fit between biofuel locations in relation to existing habitat (e.g. wetlands, remnant prairies, and so on).

- For Watonwan County EDA, Minnesota Board of Soil and Water Resources, Minnesota Pollution Control Agency and other stakeholders concerned with water quality improvements in Watonwan River and surface waters, improvements to water quality from land-cover change may be relatively easy to attain, because relatively small financial payments may be sufficient to incent growers away from production of annual crops (assuming changes in current payments that incent production of these crops).

2. Given the extensive land area that is well-suited for perennial crops and plant communities, very different landscapes in terms of “look/feel” will result from these different scenarios. Therefore, there is a need for a multistakeholder process that will identify what goals and outcomes should be guiding landscape change projects associated with sustainable bioeconomic development. Failure to organize and support such a process may provoke significant future opposition and impose significant costs.

3. Given the extensive land area that is well-suited for perennial crops and plant communities, there is a need to anticipate landscape scale changes that may occur and lead to unintended consequences, such as significant changes in regional hydrology that may affect a wide range of stakeholders.

APPENDIX

Environmental Factors and Scenario Matrix

Table 1

Factor	Scenario											
	Precision Conservation			Grassland Biomass			Woody Biomass			Pride of Place		
	A	B	C	A	B	C	A	B	C	A	B	C
Slopes >12%	+	+	+		+	+					+	+
Slopes 6-12%		+	+			+					~	~
Slopes 6-10%								+	+			
Slopes 2-6%, <200' from surface water		+	+									
Square field boundaries, honoring existing homesteads and roads			+						+		+	+
Very poorly drained soils				+	+	+		--	--			~
Wetland soils (v. poorly drained, good wetland potential, poor/very poor grass potential)							+		+			+
<200' from perennial surface water						+				+		
<100' from intermittent streams										+		
Road and railroad rights-of-way										+		
Near existing habitat units											+	+
Continuously connected habitat											+	+
20% wetland, 20% grassland goal												+

+ = factor explicitly selected in creating scenario
-- = factor explicitly removed from possible selection
~ = factor considered in creating scenario, but not selected in all cases

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2A. Willow and meadow mosaic for biomass and denitrification.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Willow and meadow mosaic for biomass and denitrification 1. Potential percentage of plant community coverage for willow, prairie, and wetland: 20% willow, 50-60% grasses, and 20-30% wet meadow and wetland 2. Planting scheme: Prairie scrub, grass, and wetland mosaic	1. Native willow and wet prairie species will be preferred. 2. People have higher preference for prairies with flowering plants with bold color. The flowering plants are not dominant in this plant community. 3. Controlled burns may need to occur in prairie areas	1. Wet riparian areas and adjacent areas will be preferred. 2. Areas without drainage tiles will not be preferred. 3. Wetland areas will not preferred.	A. Habitat values 1. This plant community may increase game and grassland birds abundance and richness as well as some waterfowl species depending on availability of open water and wetland complexes. 2. Remnant habitats must be protected. 3. Invasive plant species are undesirable. B. Goals for habitat enhancement 1. The goal will be to diversify and interconnect mosaics of prairies, scrub, wetlands, and fallow fields with small patches of woodland and riparian vegetation. 2. Wetlands and other remnant habitats should be left alone as much as possible, so as not to disturb important existing habitats. C. Cultural values 1. This plant community will increase pride of place by increasing number and variety of human experiences in the towns, farmsteads, and agricultural lands. D. Goals for cultural enhancement 1. The goal will be to diversify the aesthetic value of the prairie landscape with improved visual legibility and coherence with strategically placed vegetation in the landscape. 2. In some areas, there will be opportunities to create scenic byways that emphasize local history, unique cultural features, and seasonal variations of prairie grasses and flowers, especially along roadsides. 3. The improvement of seasonal appearance of landscapes will happen through the strategic selection of native plants with exceptional winter plant form, flowers, leaf color and texture, and fall color will be important. 4. This plant community will promote agritourism in the region.	Scenario 1 Precision Conservation Scenario 2 Woody Biomass Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2B. Prairie polycultures and shrub mosaic for biomass and biodiversity restoration.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Prairie polycultures and shrub mosaic for biomass and biodiversity restoration 1. Potential percentage of community coverage for prairie polyculture and shrubs: 70-80% prairie polyculture and 20-30% shrubs. 2. Planting scheme: prairie polyculture and shrub mosaics	1. Native willow and wet prairie species will be preferred. 2. People have higher preference for prairies with flowering plants with bold color. The flowering plants will not be dominant in this plant community. 3. Controlled burns may need to occur in prairie areas	1. Hilly upland sites will be preferred.	A. Habitat values 1. This plant community may increase game and grassland birds abundance and richness as well as some waterfowl species depending on availability of open water and wetland complexes. 2. Remnant habitats must be protected. 3. Invasive plant species are undesirable. B. Goals for habitat enhancement 1. The goal will be to diversify and interconnect mosaics of prairies, scrub, wetlands, and fallow fields with small patches of woodland and riparian vegetation. 2. Wetlands and other remnant habitats should be left alone as much as possible, so as not to disturb important existing habitats. 3. This plant community will increase habitat quality for grassland birds, but it will depend on their habitat needs and harvest methods. The size, density, and shape of the prairie polycultures will matter for some wildlife species that are area-sensitive and disturbance-sensitive. For example, the experts at the Iowa State Extension (Teel et al., 2003) found that birds benefit most from a mix of harvested and unharvested patches of switchgrass. Predation could be a major issue for nesting success. See Koford (1999) for examples of nesting on CRP lands. C. Cultural values 1. This plant community will increase pride of place by increasing number and variety of human experiences in the towns, farmsteads, and agricultural lands. D. Goals for cultural enhancements 1. Same as the willow and meadow community for biomass and denitrification.	Scenario 1 Precision Conservation Scenario 2 Grassland Biomass Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2C. Poplar woodlot mosaic for forest products and biomass.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Poplar woodlot mosaic for forest products and biomass 1. Potential percentage of poplar community coverage: 50% trees, 20% shrubs, and 30% grasses. 2. Planting scheme: tree, shrub, and grass mosaic.	1. Hybrid poplars and native poplar species will be preferred.	1. Hilly upland sites will be preferred.	A. Habitat values 1. This plant community may provide cover for wildlife species. 2. Remnant habitats must be protected. 3. Invasive plant species are undesirable. B. Goals of habitat enhancement 1. Groundcover will be needed for establishment. Other issues include the need for corridors or strips to improve biodiversity conservation value as well as the need to determine how to ameliorate any negative effects of large stands of these trees in the prairie. 2. Remnant habitats will need to be mapped and could be part of a habitat protection system that includes the poplar woodlot mosaic. C. Cultural values 1. The woodland patterns will add visual variety in the prairie landscape, but they must “fit” in visually and ecologically. D. Goals for cultural enhancements 1. A naturalistic approach would locate trees in the typical places where trees occur in the prairie landscape. 2. Another option could include a small tree plantation arrangement that would be scattered across the prairie. The Madelia area does have a few examples of this arrangement in the current landscape. 3. This plant community will be strategically planted to provide different spatial and cultural experiences along roadsides and provide seasonal interest. 4. The goal will be to diversify the aesthetic value of the prairie landscape with improved visual legibility and coherence with strategically placed vegetation in the landscape, including wildlflowers. 5. This plant community will promote agritourism in the region.	Scenario 3 Woody Biomass Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2D. Hazelnut groves for oil and food uses.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Hazelnut groves for oil and food uses 1. Potential percentage of hazel grove community coverage: 50% trees, 20% shrubs, and 30% grasses 2. Planting scheme: These plants would be planted in strips or in mosaics with other plant species.	1. Native hazelnuts with native grasses and forbs will be preferred. 2. People have higher preference for prairies with flowering plants with bold color. The flowering plants are not dominant in this plant community.	1. Upland sites will be preferred.	A. Habitat values 1. This plant community would be part of larger habitat conservation plan. 2. Remnant habitats must be protected. 3. Invasive plant species are undesirable. B. Goals for habitat enhancement 1. It will depend on wildlife species. USDA Plant Guide for *Corylus americana* (Nesom and Moore, 2006a) states nuts are eaten by a variety of mammals, birds, and game birds, and the dense canopy provides cover for wildlife. 2. Remnant habitat patches should be identified and set aside for protection. C. Cultural values 1. The woodland patterns ad visual variety in the prairie landscape, but they must “fit” in visually and ecologically. 2. Hazelnuts have cultural and historic values as a food crop (Nesom and Moore, 2006a). D. Goals for cultural enhancements 1. The plantings of hazelnuts can be expanded to include a variety of other shrubs and perennials to increase visual interest and habitat quality. 2. A naturalistic approach will locate shrubs in the typical places where they occur in the prairie landscape. 3. This plant community will be strategically planted to provide different spatial and cultural experiences along roadsides and provide seasonal interest. 4. This plant community will promote agritourism in the region.	Scenario 2 Grassland Biomass Scenario 3 Woody Biomass Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2E. Upland pasture mosaics for management-intensive grazing.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Upland pasture mosaics for management-intensive grazing 1. Potential percentage of upland pasture community coverage: 60-70% pasture, 10-20% shrubs, 10% trees, and 10% wetlands/drainage areas. 2. Planting scheme: pasture will be dominant in a mosaic with shrubs, trees, and wetlands.	1. Upland-adapted forage species will be preferred. 2. Overgrazing will decrease the diversity of plants in the prairies. 3. Controlled burns may need to occur in prairie areas to maintain prairie plant diversity and decrease woody plant invasions.	1. Upland sites will be preferred. 2. Wetland areas will not be preferred.	A. Habitat values 1. Habitat for grassland birds may be enhanced depending on availability of suitable cover habitat, such as tall grasses and shrubs. 2. Remnant habitats, such as wetlands and prairies, must be protected. 3. Invasive plant species are undesirable. B. Goals for habitat enhancement 1. This plant community may increase game and grassland birds abundance and richness as well as some waterfowl species depending on availability of open water and wetland complexes. 2. Wetlands and other remnant habitats should be set aside and protected. C. Cultural values 1. The negative impacts of overgrazing could decrease plant diversity, soil productivity, habitat quality, and visual quality. 2. This plant community may increase pride of place by increasing number and variety of human experiences in the towns, farmsteads, and agricultural lands. 3. Animal waste will need to managed to reduce odor and water quality concerns. D. Goals for cultural enhancement 1. This plant community could be strategically place to provide different spatial and cultural experiences along roadsides and increase seasonal interest. 2. The improvement of seasonal appearance of landscapes will happen through the strategic selection of native plants with exceptional winter plant form, flowers, leaf color and texture, and fall color will be important. 3. This plant community will promote agritourism in the region.	Scenario 1 Precision conservation Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2F. Riparian silvopastoral mosaics for management-intensive grazing.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Riparian silvopastoral mosaics for management-intensive grazing with some trees 1. Potential percentage of community coverage: 40-50% grasses, 30-40% trees, and 10-30% shrubs. 2. Planting scheme: grass will dominant in a mosaic with some trees and shrubs.	1. Native pasture mix with some trees and shrubs 2. People have higher preference for prairies with flowering plants with bold color. The flowering plants are not dominant in this plant community. 3. Overgrazing will need to be carefully managed because it will decrease the diversity of plants in the prairies. 4. Contolled burns may need to occur in prairie areas.	1. These sites will be preferred: riparian areas and areas without drainage tiles. 2. Small tree plantations will be another possibility.	A. Habitat values 1. Plant species that increase value for wildlife (i.e., grassland birds and migrating birds) are desirable. 2. Remnant habitats, such as wetlands and prairies, must be protected. 3. Invasive plant species are undesirable. B. Goals for habitat enhancements 1. The goal will be to diversify and interconnect mosaics of prairies, scrub, wetlands, and fallow fields with small patches of woodland and riparian vegetation. 2. Wetlands and other remnant habitats should be set aside and protected. 3. Remnant habitats will need to be mapped and could be part of a habitat protection system that includes the riparian silvopastoral woodlot mosaic. C. Cultural values 1. The woodland patterns will add visual variety in the prairie landscape, but they must “fit” in visually and ecologically. 2. This plant community will increase pride of place by increasing number and variety of human experiences in the towns, farmsteads, and agricultural lands. D. Goals for cultural enhancements 1. The goal will be to diversify the aesthetic value of the prairie landscape with improved visual legibility and coherence by strategically placed vegetation in the landscape. 2. A naturalistic approach would locate trees in the typical places where trees occur in the prairie, such as drainage areas, but careful assessment will be needed. 3. In some areas, there will be opportunities to create scenic byways that emphasize local history, unique cultural features, and seasonal variations of prairie grasses and flowers, especially along roadsides. 4. This plant community will promote agritourism in the region.	Scenario 1 Precision Conservation Scenario 2 Grassland Biomass Scenario 3 Woody Biomass Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2G. Woody floral mosaics for high-value commodity production.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Woody florals mosaics for high-value commodity production 1. Potential percentage of community coverage: 50% shrubs and 50% grasses. 2. Planting scheme: Bittersweet (*Celastrus scandens*) and other decorative species, native forbs and grasses interspersed or in strips.	1. Native dogwoods and willows will be preferred. 2. People have higher preference for prairies with flowering plants with bold color. The flowering plants are not dominant in this plant community.	1. Upland sites that are not too dry will be preferred.	A. Habitat values 1. It will depend on species and spatial arrangements. For example, *Celastrus scandens* provides cover for some species. The U.S.D.A. Plant Guide (U.S.D.A N.R.C.S. Northeast Plant Materials Program, 2006) for this species states berries are an important winter food supply for grouse, pheasant, quail, rabbit, and squirrel. 2. Remnant habitats, such as wetlands and prairies, must be protected. 3. Invasive plant species are undesirable. B. Goals of habitat enhancement 1. The goal will be to diversify and interconnect mosaics of prairies, scrub, wetlands, and fallow fields with small patches of woodland and riparian vegetation. 2. Wetlands and other remnant habitats should be set aside and protected. 3. Remnant habitats will need to be mapped and could be part of a habitat protection system that includes the woody floral mosaic. C. Cultural values 1. This plant community will increase pride of place by increasing number and variety of human experiences in the agricultural landscape. D. Goals for cultural enhancements 1. Bittersweet (*Celastrus scandens*) and other decorative species, native forbs and grasses interspersed or in strips. 2. The goal will be to diversify the aesthetic value of the prairie landscape with improved visual legibility and coherence with strategically placed vegetation in the landscape. 3. In some areas, there will be opportunities to create scenic byways that emphasize local history, unique cultural features, and seasonal variations of prairie grasses and flowers, especially along roadsides. 4. The improvement of seasonal appearance of landscapes will happen through the strategic selection of native plants with exceptional winter plant form, flowers, leaf color and texture, and fall color will be important. 5. This plant community will promote agritourism in the region.	Scenario 2 Grassland Biomass Scenario 3 Woody Biomass Scenario 4 Pride of Place

APPENDIX

Potential Plant Communities for Madelia Landscape Scenarios
Table 2

Table 2H. Native fruit groves for high-value production.

Plant Community	Anchor Species	Site Preferences	Potential Habitat and Cultural Values of Plant Community	Scenario Compatibility
Native fruit groves for high-value production 1. Potential percentage of community coverage: 50% shrubs and 50% grasses products and wild-crafting. 2. Planting scheme: These plants would be planted in small groves or mosaics with other plant species.	1. Some example species are native *Amelanchier, Viburnum,* and *Prunus.*	1. Upland sites will be preferred.	A. Habitat values 1. Some plant species will be important food and cover for wildlife. For example, the berries of *Amelanchier arborea* are eaten by many birds (Nesom and Moore, 2006b). 2. Remnant habitats, such as wetlands and prairies, must be protected. 3. Invasive plant species are undesirable. B. Goals for habitat enhancements 1. The goal will be to diversify and interconnect mosaics of prairies, scrub, wetlands, and fallow fields with small patches of woodland and riparian vegetation. 2. Wetlands and other remnant habitats should be set aside and protected. 3. Remnant habitats will need to be mapped and could be part of a habitat protection system that may include native fruit groves. C. Cultural values 1. This plant community will increase pride of place by increasing number and variety of human experiences in agricultural landscape. 2. The woodland patterns will add visual variety in the prairie landscape, but they must “fit” in visually and ecologically. 3. The phenological complexity of this landscape would be increased by integrating native fruit groves with prairie grasses and flowers with year round interest. D. Goals for cultural enhancements 1. There is potential for a unique regional landscape type when it is intergrated with prairie polycultures. There will be heritage landscape values as well. A new type of cultural landscape will be created and enhance caring for the land as well as open people to new ideas about agritourism. 2. A potential link to give Madelia a more identifiable image as community. 3. This plant community will promote agritourism in the region.	Scenario 2 Grassland Biomass Scenario 3 Woody Biomass Scenario 4 Pride of Place

APPENDIX
Policy Report

Perennial Biomass Crops in Southwestern Minnesota: Policy Pathways

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The purpose of this paper is to determine the role of policy in developing a bio-based economy in the Madelia region of Minnesota. To achieve this, the problem-based study focused on presenting policy pathways that could be, but are not necessarily achievable unless there are changes in current polices.Through interviews with policy experts at state and federal agencies, as well as non-governmental organizations, various policy constraints and opportunities were identified. This report represents a first step in the process of understanding the role that policy plays in perennial biomass production and landscape change in the Madelia region. The first section presents opportunities within a) the conservation titles of Federal Farm Bill, b) state and federal grant and subsidy programs and c) state and Federal water policy and law. The second section provides a broad overview of areas warranting further investigation.

Policy Opportunities

Federal Farm Bill
The Federal Farm Bill's commodity and conservation titles were unanimous identified as the most influential policy by the experts. The following section provides a brief overview of the major programs and potential interactions with Madelia-region bio-industrial development.

The **Conservation Reserve Program (CRP)** has been looked upon favorably by policy experts looking to integrate biomass-friendly provisions into an existing program. Its administrative design contributes to its attractiveness; landowners enter into a limited-duration contact (10 or 15 years) with the Farm Service Agency through their county office (Farm Service Agency, 2006). Often mid-contract maintenance provisions and cost-share funds are integrated into the agreement to maintain native grass or tree plantings. These same provisions could be expanded to facilitate the establishment of biomass crops through a full or partial harvest of the contract area coupled with a reduced annual payment. This would ensure the producer receives an annual return on the investment while producing environmental benefits. Another option would entail producing long term biomass crops, such as hybrid poplar, on CRP contract land and harvesting after the contract expiration. The key to getting biomass-friendly provisions integrated in these policies is well-written contracts, cooperative field professionals and well-informed landowners. The interviewees suggested that these policy alterations could be done through the county offices with approval from the state offices.

Additional research is needed to determine the full consequences of making the proposed changes. Several of the policy experts cautioned against modifying a largely successful program like CRP. The soil, water and wildlife objectives of the policy may be compromised given a shift in focus to biomass production. For example, annual harvests of native grasses would remove residual nesting and cover habitat for grassland birds. Another unintended consequence may be the placement of woody biomass crops, such as willows or dogwoods, in riparian areas that are better suited for grass bufferstrips, thereby increasing erosion and sedimentation (Natural Resource Conservation Service, 2000). Lastly, immediate conversion following the expiration of a CRP contract, as one preceding option proposes, may receive considerable resistance from professionals and interest groups considering that this practice largely undermines the long-term objectives of the program.

The **Conservation Reserve Enhancement Program (CREP)** is a jointly managed state-federal conservation program that acquires permanent and limited duration easements in selected watersheds (Natural Resource Conservation Service, 2006). After successfully targeting 100,000 acres in the Minnesota River watershed, another signup program is currently open for interested landowners in areas throughout MN, including large portions of the Madelia region (Board of Water and Soil Resources, 2006). CREP offers an opportunity to leverage federal funds; $2.3 federal dollars are matched for every state dollar through the ReInvest in Minnesota program (Minnesota Natural Resource Conservation Service, 2006). As with CRP, CREP may be useful in promoting perennial biomass crops through the contract maintenance provisions. In the Madelia region, however, this option may only be available with future signups; the second CREP signup, which has an 18,000 acre cap in southwestern Minnesota, will most likely be filled before the this option could be exercised (Board of Water and Soil Resources, 2006). Furthermore, working for biomass provision integration in future signups may be altogether unfeasible considering this region has already received two signup periods. Lastly, modification of current contracts may receive considerable resistance from wildlife interests and Natural Resource Conservation Service (NRCS) offices.

The **Environmental Quality Incentives Program (EQIP)** provides funding through local NRCS and Soil and Water Conservation District offices to producers addressing national priorities such as water quality, soil erosion, air quality and wildlife habitat (Natural Resource Conservation Service, 2006). The program provides cost-share dollars, incentive payments and sign-up bonuses to landowners based on local priorities. Priorities are set on county-by-county basis through the local Soil and Water Conservation District office; most counties have dedicated cost-share dollars to water quality issues. Most recently, EQIP funds were used in Minnesota to promote ground and surface water conservation, specifically producers using sprinkler irrigation systems (Minnesota Natural Resource Conservation Service, 2006). However, this well-funded program could be used in future years to address the establishment of perennial biomass crops in well head protection areas, tile intakes or riparian areas.

The **Grasslands Reserve Program (GRP)** offers rental payments, in addition to limited duration and perpetual easements, for landowners willing to voluntarily limit use of grazing land to conservation grazing practices, partial haying, seed harvesting or fire management (Natural Resource Conservation Service, 2006). Many policy experts see the expansion of this working-lands program as fundamental in promoting perennial biomass crops. The provisions that allow seed harvesting and partial mowing may prove compatible in harvesting native polycultures for biomass. Furthermore, land that contains semi-woody and woody shrubs, such as false indigo, dogwood and willow, is also eligible. Like all the programs major roadblocks to implementation have to be addressed. Making GRP biomass development friendly requires addressing funding shortfalls (the program has recently seen limited funding increases), limited producer interest in grassland management and a lack of promotional field staff.

The **Wetlands Reserve Program** is yet another NRCS program that offers limited term and permanent easements for landowners willing to protect or restore wetlands (Natural Resource Conservation Service, 2006). Payments, equal to the agricultural value of the land, in addition to technical assistance and full reimbursement of restoration costs are the backbone of the program. WRP has been relatively successful in Minnesota; the state lead the nation in 2005 with the number of WRP acres (over 15,000 acres) (Minnesota Natural Resource Conservation Service, 2006).

A number of biomass friendly provisions exists within the program. Haying provisions, which could be extended to biomass production, are already built into the program to control noxious weeds and improve wildlife habitat. For example, one option, allowed under current regulations, may permit a landowner to mow and bale up to 25% of the contract area during certain times of the year. Another advantage of WRP is the unique partnerships have also been forged around the contracts. Multiple landowners, government agencies, such as the US Fish and Wildlife Service, and conservation groups, such as The Nature Conservancy, have worked collaboratively on WRP projects. Spurred by the popularity of the program in Minnesota, along with a history of involving diverse stakeholders, this program may present significant opportunities for perennial biomass development. Lastly, the development of Wetlands Reserve Enhancement Program (WREP), a state-federal funding partnership similar to CREP, has successfully leveraged additional funds from the ReInvest in Minnesota program, providing a hopeful demonstration program (Minnesota Natural Resource Conservation Service, 2006).

The **Conservation Security Program (CSP)**, a Federal Farm program focused on rewarding conservation practices on working lands, has been identified by many policy experts as a model program

for integrating agricultural production with conservation practices. CSP provides payments to producers based on their voluntary conservations practices, such as the implementation of conservation tillage or the installation of filterstips. First proposed in the 2002 Farm Bill, select watersheds, including the Madelia region's own Blue Earth watershed, were selected for an inaugural signup (Natural Resource Conservation Service, 2006). In term of watersheds and funding, the CSP was substantially increased during the 2005 signup; however, most policy experts agree the program remains vastly underutilized. Due to inadequate funding and a lack of an absent or unheard advocacy voice, the full potential of this working-lands program has yet to be realized (Leher, 2005). The program is based on a non-competitive signup process; essentially an entitlement program that is too limited in terms of funding to act as such.

The CSP-style policy is attractive to policy experts for a number of reasons. The emergence of a policy that marries agricultural production with environmental conservation may promote holistic farm management; CSP extends management further than pay-for-practice programs, such as EQIP or CRP. Another reason the program is attractive to policy experts is the fact the CSP is managed over an ecological boundary (watershed) as oppose to the often arbitrary county or state lines. The program also recognizes the producers that voluntarily retire marginal cropland or install measures that improve conservation benefits on their land; other conservation programs based on commodity acreage indirectly penalize producers for such management practices. There is also a strong push, in light of recent World Trade Organization (WTO) negotiations, to begin shifting payments from commodity programs into CSP-like, green payment programs. After the 1994 Agreement on Agriculture, the WTO classified certain green payments, and other domestic subsidy programs, as "least trade distorting", effectively creating a green box of allowed programs (Diakasavvas, 2003). Leher (2005) has argued that under increased pressure over agricultural subsidies, the US could effectively replace commodity subsidies with payments through the CSP, thereby maintaining support to farmers while improving environmental benefits (Leher, 2005). CSP represents a significant opportunity for producers in the Madelia region to receive payments for growing perennial biomass crops. Shifting marginal lands from annual row crop production to native polycultures or installing harvestable riparian buffers of willows could qualify farmers for CSP payments while producing biomass revenue. Further examination into the possibilities of CSP and strategic issue-framing in the context of developing a bio-industry in Madelia would be advantageous.

The **Forest Land Enhancement Program (FELP)** provides financial, educational and technical assistance via a jointly-managed state-US Forest Service program (Natural Resource Conservation Service, 2006). Authorized by the 2002 Farm Bill, the program stated objectives include promoting sustainable forestry management by targeting non-industrial, private forest owners. Since FELP's inception, agroforestry interest groups have viewed the program as a potential avenue to expand support and funding for agroforestry initiatives (Brooks and Ffolliott, 2005). However, after the inaugural run of the program in FY2003, the program funding has been cancelled or diverted; only $5 million was available for FY2006 (Natural Resource Conservation Service 2006). To fully realize the potential benefits of this program in promoting perennial biomass crops funding would have to be renewed and expanded to include biomass production.

"Energy Reserve Program"
As discussed previously in the CRP section, there exists an inherent risk in modifying existing Farm Bill programs that are already largely successful in producing conservation benefits. An alternative would be the establishment of an additional entitlement program that focused on producing a renewable, domestic energy source through biomass energy crops. Some policy experts have coined the idea the "Energy Reserve Program (ERP)." Modeled after CRP, ERP could provide cost-share dollars, technical assistance and land rental payments to landowners who voluntarily participate in the program. The ERP proposal may prove to be valuable as markets for biomass crops develop and additional funding for such program is identified. A major limitation to proposals, such as the ERP, would likely be funding. Currently, promising programs, such as the CSP, are under funded; proposing additional policies that compete for similar funds may be counterproductive. However, as interest grows in domestic energy sources, efforts focused on designing proposals to increase biomass supply, while providing environmental benefits, may prove fruitful.

Other Programs
The ReInvest in Minnesota (RIM) program was established in 1986 to provide funding for programs that protect soil and water quality, provide fish and wildlife habitat and retire marginal cropland. RIM is administered by the Board of Water and Soil Resources in cooperation with other federal, state and local agencies (Board of Water and Soil Resources, 2006). The program leverages money primarily through bonding; the NRCS's CREP program, the Department of Natural Resource's RIM Critical Habitat program and BWSR's Permanent Wetland Preserves program all use RIM funding. In addition to these programs, RIM also funds other important conservation initiatives set forth by sportsmen groups, SWCD county offices and landowners (Korczak and Gran, 1986). In terms of addressing funding shortfalls and providing flexible dollars, the program is popular with policy experts. Within the broad objectives of the program (wildlife habitat, water quality, etc.), bio-industrial interests could potentially use the program's cost share or easements provisions to assist the establishment and maintenance of perennial biomass crops. However, major roadblocks do exist: the administrative rule language currently prohibits mowing, wildlife habitat alteration or crop production (Minnesota House, 2006). Therefore, RIM may be valued more for its potential, given expansion of policy objectives, then in its current form.

The preceding policy opportunities identified are a snapshot of the potential Federal and state programs conducive to biomass development efforts. The diverse mix of funding sources and technical assistance available at various levels poses a challenge to interest groups attempting to identify and pursue fruitful policy pathways. The next section, gives an overview of the important role of grants and governmental spending in biomass development. All the policy experts and research highlighted the tremendous influence that fiscal policy has on complex, multifaceted projects such as Madelia bio-industrial development.

The Role of Grants and Government Spending in Bio-Industrial Development
A key aspect of promoting bio-industrial development in the future will be attracting funding and subsides to help finance pilot projects, conduct research and reduce investment risk in the short and long term. Governmental agencies and private organizations may largely influence the future of bio-industrial projects through grants and loans. The expert interviews drew particular attention to new initiatives set forth by

the US Department of Energy and Department of Agriculture. The expansion of the agency's rural development and renewable energy initiatives may provide an opportunity to financially support first-step projects or research. Other sources of funding exist within the federal Department of Commerce, Environmental Protection Agency and the Department of Agriculture. Private sources should also be explored. For example, bio-industrial development funds may be derived from programs such as Xcel Energy's Renewable Development Fund (Xcel Energy, 2006). In exchange for storing nuclear waste at the Prairie Island plant, a Minnesota statue requires Xcel to create a fund dedicated to research and development of renewable energy projects. With over $53 million committed since the first round of funded projects in 2001, the fund represents a significant source of available dollars (Minnesota Session Laws, 2003). The expert interviews suggested that attracting these lucrative grant and loan dollars may be vital to the success of such a project; the financial support may "make or break" the likelihood of developing a bio-industry in southwest Minnesota.

The growth of the **ethanol** industry in Minnesota has been both championed and criticized by environmentalists, politicians and farmers alike. Conflicting life cycle analysis conducted by federal agencies, universities and private interest groups have spurred much controversy into the energy efficiency of ethanol (Pimentel1 and Patzek 2005; Alternative Net Energy Balances, 2005). In addition, interest groups have attempted to bolster ideological campaigns; domestic energy supply, farmer cooperatives and rural development have all been touted as beneficial outcomes of ethanol production. In turn, other interests argue that ethanol subsidies interfere with free trade, slows more efficient alternative energy development and further fund the already heavily subsidized crop. Controversy aside, the ethanol industry, according to the MN Department of Agriculture, has provided an estimated $1.3 billion in annual net benefits in Minnesota, supplies over 6,500 jobs in rural communities and has consumed a $0.20/gallon state subsidy since the program inception in 1986 (Minnesota Department of Agriculture, 2006). On the Federal level ethanol producers are eligible for a $0.51/gallon tax credit, in addition to the recently pass Energy Policy Act which mandates up to 7.5 billion gallons of renewable fuel added to gasoline by 2012 (Energy Policy Act, 2005). The interviewed policy experts view ethanol as both a barrier and stepping stone to bio-industrial development.

Ethanol has experienced success for a number of reasons including, but not limited to, well-organized producer groups, federal and state tax credits, improved ethanol production technology and well-run public relations campaigns. Cellulosic ethanol, a fuel made from plant material such as crop residue or switchgrass, is an integral part to bio-industrial development in Madelia. To take advantage of this growth in the ethanol market, cellulosic ethanol interests have to develop inventive ways to incorporate perennial biomass crops into the corn-dominated industry.

One potential option identified by the policy experts involves concentrating on enzymatic development, producer education and marketing. More efficient ways to ready cellulose for fermentation must be developed before cellulosic ethanol is competitive with grain ethanol. In addition, demonstrating to producer that higher yields of fermentable sugars are obtainable with perennials on certain sites should be undertaken. Another option involves promoting policy that distinguishes between grain and cellulosic ethanol sources. The Federal Energy Policy Act has provisions that encourage investment and adoption of energy sources that derive ethanol from non-grain sources (Federal Energy Policy Act, 2005). Encouraging the expansion of this Federal policy and expanding this to the Minnesota ethanol policy may further perennial biomass development.

However, both of these options present problems for interests looking to blend conservation with cellulosic ethanol production. The demand for corn, spurred by the ethanol industry, will most likely increase land rent values making the adoption of alternative crops or conversion of marginal cropland less likely. In addition, rising land rent values may reduce participation in state and federal conservation program; land generates more revenue from corn production. Furthermore, integrating perennial biomass crops into annual row crop systems may become less economically attractive given a strong corn market. The preceding factors and their outcomes will determine if ethanol policies present themselves as constraints or opportunities. Broadly, ethanol development has in many ways demonstrated that bio-industrial development is an option in the region. Largely influenced by favorable tax credits, and supportive policies, the growth in the grain ethanol market has paved the way for future projects.

State and Federal Water Policy and Law

A complex, well-funded sector of natural resource policy is the regulatory and non-regulatory polices addressing water quality in the Minnesota. Within these policies there exists a growing shift to begin addressing non-point source pollution across watersheds and, in turn, opportunities to address these issues with perennial cropping systems.

The **Clean Water Act of 1972 (CWA)** is a powerful piece of federal legislation, administered by the Environmental Protection Agency, which provides regulatory policies to address pollutant discharges, grants to finance municipal wastewater treatment facilities and regulatory and non-regulatory programs to manage polluted runoff (Environmental Protection Agency, 2006). The provisions to highlight in the context of promoting perennial biomass cropping system are the non-point source pollution sections within the CWA: Section 319 grants and State Revolving Funds loans (SRF).

The 319 grants allow local governments and state agencies, among other groups, to apply for funding from a fluctuating federal account ($237 million in FY2005). These grants can address non-point source pollutions through flexible cost-share, restoration or educational programs. The second fund, the SRF, provides zero or low interest loans to local government units to fund municipal wastewater treatment facilities in addition to a limited number of non-point source pollution projects (Environmental Protection Agency, 2006). By far the largest source of funding through CWA, the SRF draws money from an annual fund of $4 billion dollars, of which, Minnesota received $3.9 million in FY2006 for non-point source pollution projects (Environmental Protection Agency, 2006). The key to leveraging this money is matching state funding (40% and 20% for 319 grants and SRF loans, respectively). To raise matching funds, Minnesota has created several programs, most notably the Clean Water Partnership Program and the Clean Water Legacy Act.

The **Clean Water Legacy Act (CWL)** is a broad-based coalition's legislative solution to decreasing water quality. Fueled by the impact of decreasing water quality on drinking water sources, recreation, fisheries and wildlife and development, a coalition of business interests, agricultural groups, environmental groups and local governments pushed through legislation that would provide additional money to address point source and non-point source pollution (Impaired Water Stakeholders Report, 2005). Although the funding source is unconfirmed (an initiative to charge a progressive water user fee failed in 2006), short term funding was appropriated to fund the CWL's $5 million TMDL grant program, $2.3 million Phosphorus Reduction grant program and $1.1 million dollar Small Community Waster Water Treatment Program (Minnesota Pollution Control Agency, 2006). Many policy experts see this money as merely a drop in the bucket when it comes to addressing non-point source pollution, however, the passage represents a first

step in leveraging funding from federal sources.

The other state water policy that is important in funding non-point source pollution projects in the **Minnesota Clean Water Partnership program (CWP)**. CWP is a state-funded project managed in conjunction with the federally-funded 319 grants by the Minnesota Pollution Control Agency (MPCA). The funding involves approximately $5.6 million annually in grants and loans (Minnesota Pollution Control Agency, 2006). This funding can be used for investigation and implementation projects, such as filterstrips or bank stabilization projects.

The next section attempts to answer two questions: why the experts identify these water policies as important in developing a biomass industry in Madelia and how do policies that target non-point source pollution fit into perennial cropping systems?

The preceding water policies are well funded and often widely supported. These policies represent the most politically and financially enduring pathways to address water quality. The new funding that was created by the CWL was largely influenced by the recent findings that many of the tested waters in the state do not meet the Total Maximum Daily Load's (TMDL) laid forth under the Federal Clean Water Act. The list of impaired water bodies continues to grow as monitoring is expanded; 284 streams and rivers and 1013 lakes are impaired for one or more pollutants (Minnesota Pollution Control Agency 303(d) list, 2006; Minnesota Legislative Fact Sheet, 2006). Furthermore, state water policies have been largely successful in creating matching funds to bring in large federal dollars from the coffers of CWA programs. Much of the highlighted policies also exhibit flexibility in both the types of activities and organizations the program are willing to fund. For instance, Section 319 grants will fund implementation and demonstration projects to diverse groups such as lake associations, municipalities and universities.

Due to the fact that these Federal and state water policies are often well-supported and flexible, there exists significant opportunities to support perennial biomass systems. The MPCA recognizes that 86% of pollution is the result of non-point sources, a large portion of those from agricultural production (Minnesota Pollution Control Agency, 2006). A strong interest, along with related money, to develop a system that mitigates the detrimental effects of annual row crop production subsists. To improve water quality, partial conversion of these systems to perennial biomass crops or strategic placement of riparian plantings, may receive strong public support. In addition, as more impaired water bodies are identified and more attention is paid to TMDL's in the legal arena, there will be significant interest in addressing the non-point source pollution problems. The provisions laid forth in legislation, such as the CWA, may spur interest in conservation practices from developers, city governments and business interests. Marketing biomass crops as an alternative solution to addressing impaired waters/TMDL's and getting biomass species written into the ensuing riparian and filter strip plantings, may be beneficial in promoting a biomass industry.

Well-Head Protection

The incorporation of perennial biomass crops into drinking water policy and source wellhead protection areas (SWPA) may protect groundwater while providing for the multiple benefits of perennial cropping systems. MPCA testing has found that 3% of the private and public wells tested exceed the 10mg/L nitrogen-nitrate levels health standards (Minnesota Department of Agriculture, 1998). Furthermore, many communities are faced with mounting costs attempting to maintain nitrate concentrations below the 10 ppm standards set by the Federal Safe Drinking Water Act (104th Congress, 1996). To maintain safe nitrate levels in drinking water, the DOH has conducted universal well testing, mandated the establishment of Source Wellhead Protection Areas and compelled communities, through cost share and technical assistance, to develop plans for addressing nitrate levels (Minnesota Department of Health, 2006).
The options currently available to communities are sparse; drilling addition uncontaminated wells to blend with contaminated drinking water or installing nitrate removal systems are the immediate choices. Both of these options are often prohibitively expensive for small communities with the latter being an option only if uncontaminated aquifers are unavailable (Minnesota Pollution Control Agency, 2006). A third option, one highlighted in the interviews as a potential option to supplying a bio-industry in Madelia, targets land-use in the SWPA via land retirement programs and perennial cropping systems.
The advantages of pursuing the land use option include: comparatively lower costs, the integration of payment for environmental services programs, and the implementation of longer-term solution. However, the land use option doesn't address immediately address nitrate-contaminated drinking water (unlike a treatment plant), requires an investment in educational and technical resources and isn't available to all geological regions (this option targets lands with course textured soils or travel recharge areas of short duration)(Minnesota House, 1989; Minnesota Pollution Control Agency, 1998). For the Minnesota communities the choose to take the land use option, reducing nitrogen applications rates and shifting to perennial cropping systems may be able to address the 64% that agricultural inputs contribute to nitrate-contaminated groundwater (Minnesota Pollution Control Agency, 2006). Promoting perennial biomass crops as an option to the communities in Minnesota that are, or will soon face, problematic nitrate levels may increase adoption. In addition, localized land use changes may provide payments from community water users, to producers to establish and maintain perennial crops in strategic areas. Lastly, the communities are able to capitalize on the benefits that perennial biomass crops provide while more efficiently applying nitrogen inputs, maintaining yields and providing alternative markets.

Other Water Policies

There exist other water policies that, although was not identified during the expert interviews as potential policies players, may still represent significant opportunities. The following policies and programs deserve further investigation as to their influence on bio-industrial development in the Madelia region:

- Minnesota Department of Agriculture's Energy and Sustainable Agriculture Program, Agricultural BMP program and Ground and Surface Water Monitoring Program.
- Minnesota 1989 Comprehensive Groundwater Protection Act, specifically the Nitrogen Fertilizer Management Plan.
- Minnesota Pollution Control Agency's Clean Lakes Program and Minnesota River Project.
- Minnesota Board of Soil and Water Resources Permanent Wetlands Reserve program, Feedlot Water Quality Management Program and Non-point Engineering Assistance Program.

Further Iinvestigation

The opportunities for bio-industrial development are ever expanding. This policy report was designed to begin the process of identifying current options and movements in varying degrees of pursuit. The list of policy constraints and opportunities is always growing as political climates changes, agendas are modified and new ideas are engaged. The following list presents ideas have come about through research, conversations and interviews with policy experts. The precise effect of these events and ideas on bio-industrial development in southwestern Minnesota warrants further investigation:

- The future of US agricultural commodity programs as they relate to increasing pressure from the World Trade Organization.
- The result of continued or increased Federal spending on the Iraq War and the effect on domestic development, natural resource and agricultural policy.
- Global energy prices and the effect on renewable energy initiatives.
- Agenda setting by the state and Federal level administrations.
- Policy addressing climate change and its effect on energy, carbon sequestration and U.S. policy.
- State-level initiatives to raise additional support for arts, humanities and the environment and its effect on local energy and conservation projects.
- Global warming and potential shifts in regional climate and precipitation patterns.

Energy, environmental and agricultural policy opens many doorways in developing a bio-industrial economy in southwestern Minnesota. The expert interviews and collaboration with producers, land managers, educators and researchers have identified common policy pathways. Several of these pathways are broadly surveyed in this report including the Federal Farm Bill, Federal and state conservation programs and water law and policy. The next step is to identify which options are most likely, through collaboration with the Madelia community, and pursue those most beneficial.

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